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Fig. 2

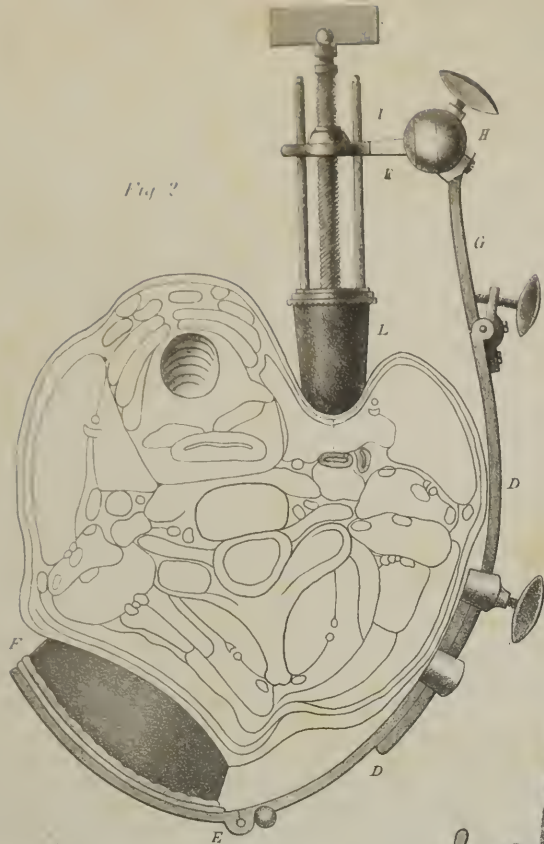


Fig. 1

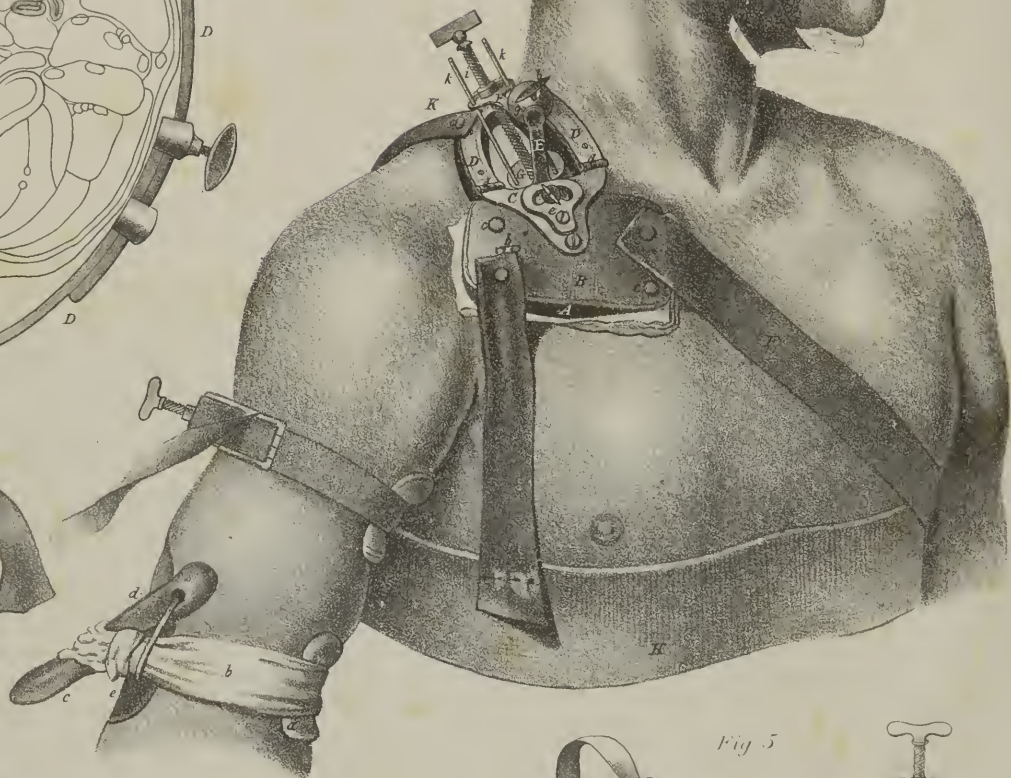


Fig. 3



Fig. 4

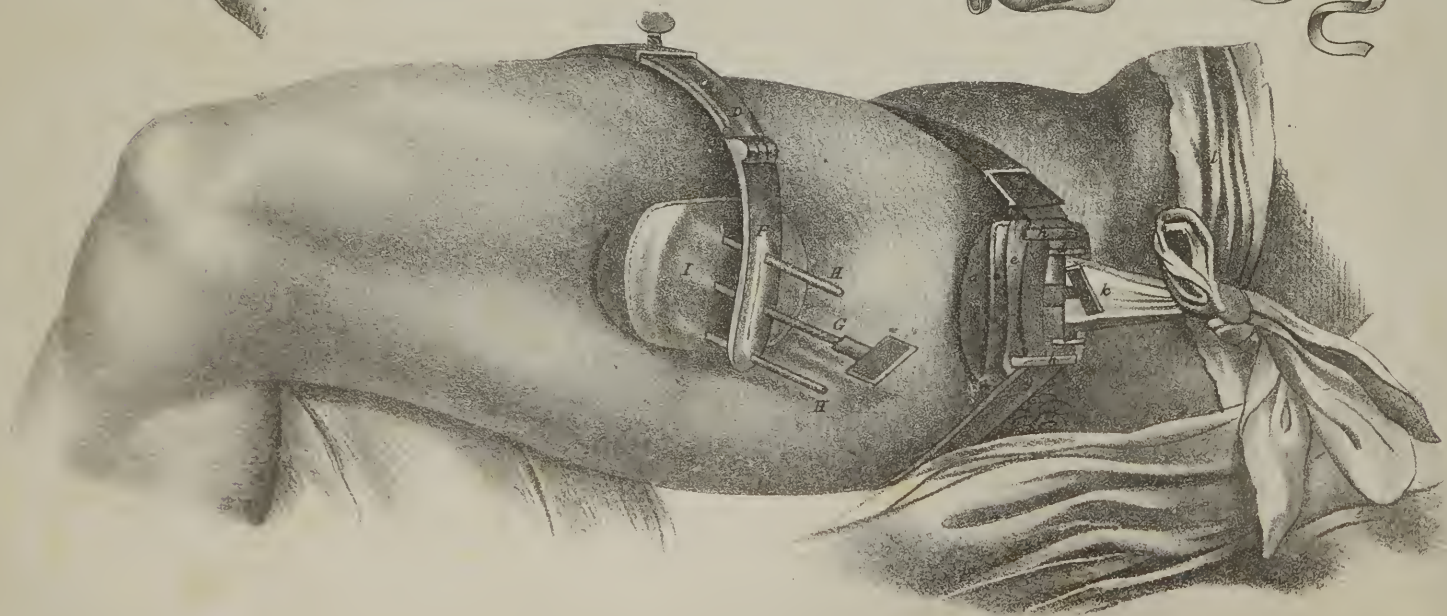


Fig. 5



A T R E A T I S E
ON
O P E R A T I V E S U R G E R Y ;

COMPRISING
A DESCRIPTION

OF THE
VARIOUS PROCESSES OF THE ART,
INCLUDING
ALL THE NEW OPERATIONS;
EXHIBITING
THE STATE OF SURGICAL SCIENCE IN ITS PRESENT ADVANCED CONDITION;

With Eighty Plates,
CONTAINING FOUR HUNDRED AND EIGHTY-SIX SEPARATE ILLUSTRATIONS.

THIRD EDITION, REVISED AND ENLARGED.

BY JOSEPH PANCOAST, M. D.,

PROFESSOR OF GENERAL, DESCRIPTIVE, AND SURGICAL ANATOMY IN JEFFERSON MEDICAL COLLEGE, PHILADELPHIA;
LECTURER ON CLINICAL SURGERY,
ETC. ETC.



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ADVERTISEMENT TO THE SECOND EDITION.

IN issuing a new edition of the *Operative Surgery*, the publishers are desirous of offering their acknowledgments to the medical public for the unexampled favour with which the work has been received—an edition of two thousand copies having been exhausted in less than eighteen months from the time of publication.

In the former advertisement the author expressly disavowed his intention to do more than give the operative surgery of the day as he best understood it, with the surgical anatomy of the parts concerned, and such brief details in reference to the pathology and therapeutical management of surgical affections as seemed absolutely necessary—a condensed, comprehensive, and purely practical treatise like this not being the place for discussing at large principles in surgery or settling controverted claims to the earliest performances of particular processes, which local prejudices and national rivalry must ever render an ungracious task. On the grounds thus assumed in preparing his work, he alone deems himself amenable to criticism; and, on carefully revising and enlarging it for a second edition, he has found no reason to change his plan. All descriptions of operative processes, like those of mathematical problems, must, if correct, be to a certain extent analogous, and while the author has been earnestly desirous of doing no one injustice, he believes that the question, who has given them most clearly and intelligibly, is the one which mainly interests the profession at large. The plan of describing fully and systematically the operations of surgery apart from lengthened therapeutical details, is new to the science; not an instance of it, prior to the appearance of this work, being found in the whole range of English literature: for while British surgeons have borrowed freely from the French, both as regards processes and illustrations, they have not taken from them at the same time their scientific order and arrangement. But three works have previously appeared on this plan—those of MM. Velpeau, Malgaigne, and Bourguery, from the last of which, as well as from the numbers of *Froriep*, as duly acknowledged in the advertisement to the first edition, the author has been most indebted in the preparation of his work. The text of the three French surgeons above mentioned, as it has been drawn from the same sources, must of necessity have close analogy in language and arrangement. M. Bourguery has followed closely the systematic classification of operations adopted by M. Malgaigne, and as this is the natural classification, the author of this work did not deem it best to vary greatly from the same plan. Since the publication of the first edition, the sheets of M. Bourguery, from the subject of *Hernia* to the conclusion of his splendidly illustrated work, have reached the author, and he has availed himself of them to a certain extent in preparing the present edition.

ADVERTISEMENT TO THE FIRST EDITION.

THE necessity of thoroughly illustrating the operations of Surgery, has been felt from the earliest periods of the art, as a means of rendering the processes for their performance intelligible to the student. Almost every modern surgeon of distinction, and especially Camper, Scarpa, Cooper, Hesselbach, Bell, and Dupuytren, have, in particular departments of the science, contributed much to the attainment of this most desirable end. The attempt to collect the newest and completest modes of illustration into a continuous whole, has been made but in two instances—by M. Froriep of Berlin, who has issued them in numbers, without any other regard to order than the time of their appearance, and by M. Bourgery of Paris. The voluminous and expensive character of these works, and especially of the latter, which is as yet but little more than half completed, as well as their being clothed in a foreign language, renders them in a great degree inaccessible to the American surgeon. With these admirable treatises before him as a guide, and having at hand the greater portion of the surgical works which have recently appeared in various languages, and with the advantage which nine years' continuous service in one of the largest hospitals of North America has given him, not only in comparing to a certain extent the value of the different methods, but in enabling him to obtain a large number of accurate drawings of operations which have been done by his own hand, the author has endeavoured to furnish a work that shall represent, so far as its limits will allow, the operative surgery of the day. In pursuance of this desire to portray the actual state of the science, many processes of operation have been given for which the author cannot hold himself any further responsible than of having made of them a clear and impartial statement, drawn from the most authentic sources. The description of processes, too often given obscurely by their inventors, is confessedly difficult, and the author has not hesitated, when he believed he could thereby render their details more plain, to risk occasional repetition. The drawings, in almost every instance, have been represented in such a point of view that the examiner may, in the stage of the process immediately shown, consider himself as the operator.

In order to render the work still more useful to the practitioner, a brief but comprehensive description of the surgical anatomy of the parts immediately concerned has been added, as well also as some account of the pathological changes, when this was deemed necessary to the comprehension of the operation in question. It has not, however, been possible to enter into a discussion of the claims of different surgeons to particular processes, or to detail in full the therapeutical management of surgical affections, which would have expanded the work to an immoderate size. Some brief observations have, however, in the latter respect, been given, in order to assist those in forming opinions who have not other means at hand for consultation, but without invalidating the claims of this work to be especially considered as a PRACTICAL TREATISE ON OPERATIVE SURGERY. In the prospectus, the work was announced as consisting only of seventy plates, containing two hundred and fifty separate figures, with from two hundred to two hundred and fifty pages of illustrative text. But as these limits were found too restricted for so copious a subject, the publishers, with a liberality that does them honour, have consented, without increasing the price to subscribers at the time of publication, to its extension to its present dimensions, which will be found to consist of eighty quarto plates, comprising four hundred and eighty-six separate illustrations, and three hundred and eighty quarto pages of description.

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PART FIRST.

ELEMENTARY AND MINOR OPERATIONS.

UNDER THIS GENERAL HEAD ARE CONSIDERED, 1. THE DIVISION OF PARTS WITH THE BISTOURY AND SCISSORS; 2. DIVISION BY LIGATURE; 3. PHLEBOTOMY; 4. ARTERIOTOMY; 5. CAUTERIZATION; 6. REUNION BY SUTURE; 7. SETONS; 8. ISSUES; 9. MOXA; 10. ACUPUNCTURATION; AND 11. THE MEANS OF ARRESTING HEMORRHAGE, BEFORE, DURING, AND AFTER OPERATIONS.

I. DIVISION OF PARTS WITH THE BISTOURY AND SCISSORS. (PLATES I. & II.)

OF THE BISTOURY.

THE term bistoury is but a name for a knife, and was derived, according to Huet, from a town called *Pistori*, once celebrated for the manufacture of this kind of instrument. The term is frequently employed synonymously with that of scalpel, or the ordinary knife for dissection. Though differently shaped instruments, and for this reason especially suited to particular manœuvres, the one is frequently substituted for the other in a great number of operations; the proper bistoury being the greater favourite with the French, the scalpel with most of the English and American surgeons. The form of the common scalpel is well known and is subjected to little alteration. That of the bistoury is more varied; it may be either curved or straight, and at the same time either sharp or probe-pointed. The sharp-pointed bistoury, which is the most generally useful of all surgical instruments, may be curved upon both the edge and back with the concavity upon the cutting surface; or it may be similarly curved with the concavity upon the back, so as to give it a sabre-like appearance. It may be curved on the back only, and straight upon the edge, or it may be straight upon both edge and back, so as to give it a long narrow point, as in the needle-shaped bistoury of the French. The positions below described, apply in the main to the ordinary English scalpel, as well as to the common operating bistoury of the French, which is curved on the back and straight on the edge, as seen in the accompanying drawings.

The different positions in which this instrument is held in surgical operations, are distinguished by numerical names. Authors vary in regard to the number of these positions, as well as to the order in which they are described, and have dwelt with unne-

cessary minuteness on the subject. M. Bourguery, one of the latest surgical writers, has made eight, and classed them as follows, according to the frequency with which they are employed. In each of the positions described below, the instrument is considered as held in the right hand.

1st Position, Pl. 1, fig. 1. *The bistoury held somewhat as a knife with the cutting edge turned downwards upon the surface upon which it is to cut.*—The ends of the thumb and middle finger, the former extended and the latter flexed, are applied upon the two sides of the handle, near the heel of the blade. The fore finger is carried forward upon the back so as to rest at some place between the heel and the point, in order to augment the pressure downwards, when resisting tissues are to be cut; or applied upon one of the sides, when we wish to give additional firmness to the position of the knife, to prevent its slipping laterally. The ring and little finger flexed like the middle, rest upon the handle, the free end of which is pressed against the metacarpo-phalangeal articulation of the last finger.

This position is of all others the one that puts the bistoury most completely under the control of the hand, and is commonly preferred by the French and German surgeons, in incisions from without inwards. The facility with which the cutting edge is presented parallel to the surface, causes it to cut like a common knife in whittling along the whole extent of the blade, so as to render the division of parts more neat, more free and prompt, and at the same time less painful. The movements of the knife are effected principally by motion at the wrist and shoulder joints; they are thus rendered free and sweeping, but are not so well suited for light and delicate incisions, or when the cut is to be made directly towards the operator. For these reasons a large

majority of the English and American surgeons prefer commonly the third position in all incisions from without inwards; but when an extensive superficial cut is to be made, as in the amputation of a breast, the first position will be found decidedly preferable.

2d Position, Pl. 2, fig. 2. *Bistoury held as a knife, the cutting edge upwards.*—The instrument is held precisely as in the first position, with the exception that its cutting edge is upwards; the hand is in this, as in the first position, slightly pronated. It suits especially for incisions from within outwards, and from right to left.

3d Position, Pl. 1, fig. 5, 6. *Bistoury held as a writing pen.*—It is unnecessary to describe minutely this familiar mode of holding an instrument. The middle finger, which is extended upon the side of the blade, may be made to approach at will, more or less near to the point, so as to limit the depth of the incision, or by pressing on the side, turn the instrument as upon a pivot, between the thumb and fore finger; while the two smaller fingers, extended upon the surrounding parts, give a point of support to the hand. When held vertically, the point of the instrument may be readily applied for the purpose of making punctures as directed in some forms of erysipelas. The bistoury may be inclined more or less forward or backward in this position so as to facilitate the section of parts, but cannot be brought to the horizontal direction for the purpose of giving a sweeping cut; the section is, therefore, chiefly made by pressure, but is well suited to operations in which it is necessary to make deep but short incisions, as in the external cut for stone, or the laying bare of a deep-seated artery for the purpose of surrounding it with a ligature.

4th Position, Pl. 1, fig. 7. *The cutting edge turned towards the palm of the hand.*—The bistoury held as has just been described, may be turned between the thumb and fore finger, so as to present obliquely backwards, and come into the fourth position, ready to cut in a direction opposite to that in which it is commonly employed; that is, with the back turned towards the parts to be incised, and the edge towards the palm of the operator. This position of the bistoury is convenient for cutting from within outwards and to the left, or from within outwards and backwards.

5th Position, Pl. 2, fig. 3. *Bistoury held like the bow of a violin.*

The situation of the fingers in this, is in all respects the same as in the 1st position, with the exception of the last finger, which is elevated and free. The light hold which is taken of the instrument in the fifth position, suits for the delicate and superficial section of parts which have been previously exposed by a bolder cut; when we intend, as it were, to graze the surface of some important structure, and retract the instrument upon the least intimation of danger, as in opening the sheath of an artery, or in exposing an encysted tumour which we wish to remove entire. The division of the tissues in this case is made by slight pronating movements of the wrist.

6th Position, Pl. 1, fig. 8. *The bistoury held as a bow, with the little finger lowered.*—This position varies chiefly from the fifth, in not having the handle of the instrument supported against the ulnar margin of the hand, but resting upon the radial side of the little finger, which should be flexed. If the bistoury be held flatwise in this position, the surgeon may act with great rapidity and precision, over a large extent of surface, so as to abridge the time of operation, when the part to be removed is of considerable volume, as in the detaching of a mammary gland from over the surface of the great pectoral muscle.

7th Position, Pl. 1, fig. 10. *The bistoury held balanced by the margins of its handle, the cutting edge of the blade turned towards the operator.*—The blade is presented more or less obliquely, or entirely flat upon the parts to be divided. The thumb and middle finger half flexed, are placed upon the opposite sides of the instrument, at the junction of the blade with the handle; the index finger is carried forwards on the back of the blade. The ring and little fingers are lightly closed so as to sustain the handle more firmly. This position is commonly resorted to, when it is found necessary to make a horizontal section of a part previously raised with the forceps, in order to uncover the structure below without risk of injury, as in opening the sheath of a deep-seated vessel or the coats of a hernial tumour; the back of the instrument being kept applied against the part, which it is important to avoid.

8th Position, Pl. 1, fig. 9. *The bistoury puncturing like a trocar.*—The instrument is laid flat, upon the palmar face of the articulation of the second and third phalanges of the last three fingers. The thumb and middle finger are opposed upon its upper

PLATE I.—POSITIONS OF THE BISTOURY. INCISIONS.

Fig. 1.—Bistoury held in the *first position*; back of the instrument to the palm of the hand.

Fig. 2.—*Incisions from without inwards, and from left to right*: vertical position of the knife, with the point entered partly through the skin at the moment of commencing an incision: bistoury in the first position with the hand pronated.

Fig. 3.—Hand brought down, so as to continue the incision; the knife in the same position.

Fig. 4.—Bistoury placed in the vertical position, to show the manner in which it should be brought out after the incision is completed. By this mode of entering and withdrawing the bistoury, the surgeon renders the incision complete, and without a shelving slope at either end.

Fig. 5.—Bistoury in the *third position*, held as about to make the puncture at the commencement of an incision.

Fig. 6.—Act of cutting with the bistoury in the *third position*.

Fig. 7.—Incision upon a director in the *fourth position*, the cutting edge of the bistoury turned upwards.

Fig. 8.—*Sixth position* of the bistoury, the instrument held as a bow.

Fig. 9.—*Eighth position* of the bistoury, in the act of making a puncture with the blade flat.

Fig. 10.—*Seventh position* of the bistoury, in the act of slicing off a portion of tissue raised with the forceps.

Fig. 1.



Fig. 2.

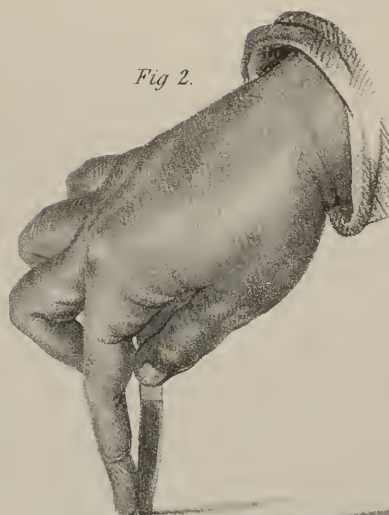


Fig. 4.



Fig. 3.



Fig. 5.

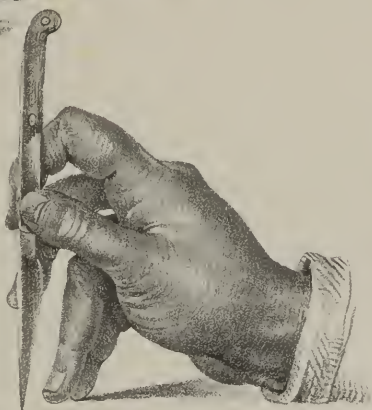


Fig. 7.



Fig. 6.

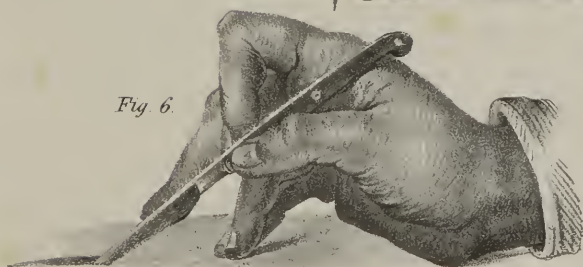


Fig. 8.

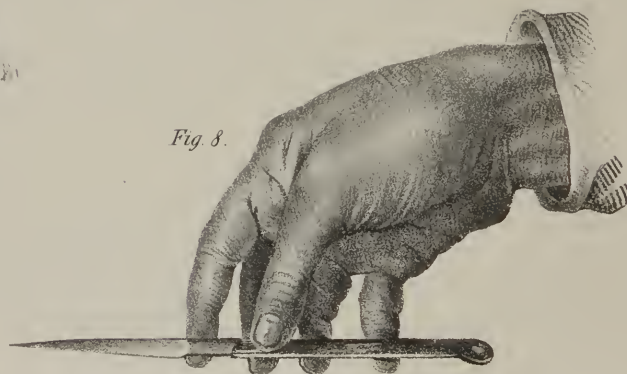
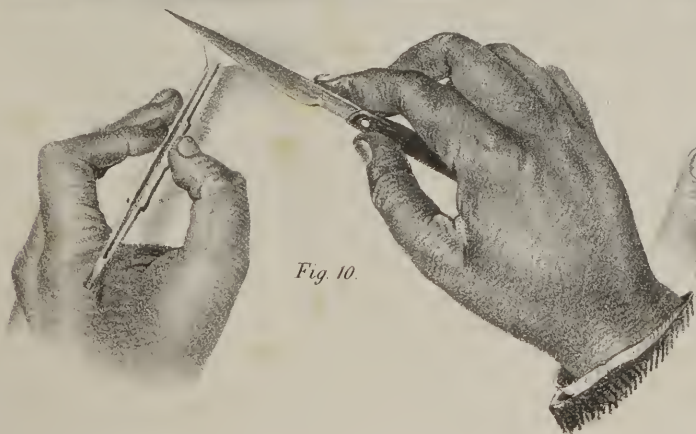


Fig. 9.



Fig. 10.



and lower faces, and the fore finger carried a little in advance upon the blade. The last three fingers are flexed so as to secure the free end of the handle against the palm. The direction of the cutting edge of the bistoury may be varied. This position with the blade presented flat, is convenient for the purpose of making punctures, as in the opening of a lumbar abscess; or if the edge be held vertical, in making a crucial or X incision, cutting from within outwards after the knife has penetrated sufficiently far.

STRAIGHT INCISIONS. (PL. II.)

These may be very briefly noticed; they are made either from without inwards, by pressing downwards with the knife, or from within outwards, by raising the parts, and running the knife through the base of the fold.

The incisions from without inwards and from left to right, are divided into the simple and compound.

Simple incisions.—Previous to every incision, the skin should be made tense either by the left hand of the operator, or, as in some cases will be necessary, by the aid of assistants. This may be done by the surgeon placing the thumb and fore finger of his left hand upon either side of the knife; by sinking in the ends of the fingers in the direction of the incision, as in cutting down upon an artery; by applying the ulnar border of the hand behind the track of the knife, and making the cross tension by the thumb and little finger; or by raising a fold of the skin with the aid of an assistant, as shown at fig. 6.

1st Process. Oblique incision with puncture, as in opening an abscess, or dividing a deep-seated fascia.—The bistoury is to be held in the first position. Tension having been made with the thumb and fore-finger, the point of the instrument is applied vertically between them, so as to be entered by puncture in the direction proper to the particular case till it has reached a sufficient depth. If it be abscess for which the puncture is made, the want of resistance to the point, the freedom with which it may be moved from side to side, and the appearance of pus on the side of the blade, indicate its arrival in the cavity. The bistoury is then to be brought more or less parallel with the surface, and by a movement of the hand from left to right, the puncture is enlarged so as to make a free exit for the pus. The incision completed, the bistoury is to be raised and removed in the perpendicular position in which it was first entered. Where important parts are concerned, it is not, however, always safe to make a bold incision in this way, at a single cut; and it will be found better to resort to one of the following processes instead.

2d Process. Incision on the flat surface of the skin without puncture.—This differs from the preceding in employing the cutting edge, for the purpose of dividing the different layers of the part from above downwards, more slowly and by successive strokes with the knife. This process is much longer and more painful, but is more safe, and is, therefore, under many circumstances to be preferred.

3d Process. Incision on a fold of skin, (fig. 6). The integuments are to be raised in a fold, in a direction transverse to that in which the parts are to be divided with the knife. The section may be made at the will of the surgeon from above downwards, by holding the bistoury in the first position and drawing it from

heel to point; or, by passing it by puncture in the second position with the edge upwards through the base of the fold, and cutting from within outwards. The skin is then relaxed, and we have a cutaneous incision rapidly made, twice as long as the height of the fold of the skin. If it requires to be further lengthened, the surgeon may raise with his thumb and finger one of the lips of the incision, and prolong it by cutting from above downward, with rapidity, safety, and with comparatively little pain to the patient.

Incision in the 7th position.—This mode of incision is peculiarly appropriate for the removal of excrescences from the skin, for the opening of the layers covering the arteries, as well as hernial and various other tumours. The convex bistoury or scalpel, is well suited to this incision. It forms a part of the proceeding in most of the great operations, and requires light and delicate manipulation on the part of the surgeon. The portion to be incised requires to be raised with the forceps, hook, or the thumb and finger; the first cut of the knife is to be made obliquely downwards, then horizontally under the end of the hook or forceps; the knife is finally brought out obliquely on the opposite side, having moved in a sort of irregular crescentic line. Slight rotatory movements of the knife between the thumb and finger of the right hand suffice to place it in the position proper for these separate steps. In removing cancerous excrescences from the face, with the object of completing the cure ultimately with the arsenical paste, we may in this way, by first raising the tumours, extirpate them below the level of the surrounding skin.

For the removal of large tumours, or even of smaller ones situated below an aponeurosis, or when we wish to remove a part at some distance from the surface, straight incisions will not afford sufficient space. Under these circumstances it becomes necessary to resort to the compound incisions. These may be either crucial, T, V, or star-shaped, and consist merely in a combination of the simple straight incisions.

COMPOUND INCISIONS. (PL. II.)

Crucial incision, fig. 5.—The first incision from left to right is made, as has already been mentioned, with the bistoury in the first position, or, if the surgeon should prefer it, in the third. The two other limbs of the cross cannot be neatly formed at a single cut, as the skin would slide before the knife on the right hand side of the wound. For this side, therefore, the skin having been previously made tense, the cut should be commenced from the bottom of the first incision; that of the other side is made in the opposite direction, or towards the first wound. The two smaller incisions may, however, if it be preferred, be made in another direction—from within outwards—by entering the knife under each lip of the first incision, passing it for the requisite distance parallel with and below the skin, through which the point is to be passed by lowering the handle, and the division effected by a cut from the point to the heel: the bistoury for the right half being changed to the left hand. The right hand may, however, be used for this latter purpose if the surgeon shift his position to one side, or which will be found more convenient, enter the point through the skin and bring it out at the centre of the first incision.

The crucial incision being made, the four angular flaps of in-

tegument are to be raised by the point, dissected up, and turned back. The sixth position of the bistoury will be found most convenient for the dissection, as the loosening of the four flaps may be completed quickly, merely by varying the movements at the wrist joint. This crucial incision is well suited to a variety of cases where we wish to expose clearly the parts below, as is necessary in the use of the trephine or the operation for hernia, and has moreover this advantage, that the flaps come afterwards readily together, and are well disposed to unite by the first intention.

Incision in the form of a T, fig. 4.—This incision differs only from the crucial in having but one branch made upon the first line of division, and is practised according to the same rules. It is employed also under similar circumstances, and can in a moment, when not found during the operation to expose the parts below sufficiently well, be transformed into the crucial.

Incision in the form of a V.—This is formed by two straight incisions, of which the second terminates by an acute angle upon one of the extremities of the first. It is employed occasionally under the same circumstances as the two just described; but as the angle should never exceed forty-five degrees, it does not in general serve so good a purpose in uncovering deep-seated parts. It is found particularly advantageous in its application upon free margins, as the lips and eyelids, for the removal of diseased portions, or for the purpose of freshening the edges in a cicatrized wound or congenital fissure.

Incision in the form of a star.—This is composed of three or four straight incisions crossing at a common centre, so as to form six or eight V shaped flaps, adherent to the surrounding parts by their bases. It is employed only in cases where it is necessary to divide the parts freely in order to remove inflammatory strangulation, or give free issue to the morbid products collected in separate cells, as in severe forms of carbuncle.

Elliptical \circ and crescentic \smile incisions.—The latter are only occasionally employed. The elliptical are in much more common use, and serve for the purpose of removing a portion of the integument, when it is redundant, as is often observed over the upper eyelid; or when it is deformed by cicatrices in parts like the neck or face exposed to view. They are employed for the removal of large tumours, as those of the testicle or mamma, in which the skin, either from its being too abundant or from its having suffered by the disease, requires also to be in part taken

away. The lower limb of the ellipse in this incision should be made first, in order to avoid the embarrassment that arises from the flow of blood, when the upper has been previously formed. In many instances, and especially when the surgeon has not had sufficient practice to make him sure of his hand, it may be well to have the lines previously traced with ink or lunar caustic, to insure that the incision shall have its proper shape. Before using the knife the parts must be made tense according to the directions given for the preceding operations. The *crescentic incision* is sometimes preferred to the elliptical for the removal of superficial parts, as the edges of the wound it leaves come afterwards very neatly together. It is formed by two lines curved in the same direction, but belonging to circles of different diameter that enclose between them a piece of skin thus \smile , which with the parts subjacent is to be removed. Incisions shaped in the form of an L, or a \perp , are also occasionally employed, as will be hereafter mentioned.

INCISIONS FROM WITHIN OUTWARDS, AND FROM RIGHT TO LEFT. (PL. II. FIG. 2.)

In these incisions the skin is to be made tense with the palm of the left hand applied flat, transversely to the direction in which the incision is to be made, and behind the place for entering the bistoury. This instrument should be held in the fourth position, and when the point has entered to a sufficient depth, the handle is to be depressed more or less toward the ulnar margin of the left hand, so as to elevate the parts with the cutting edge, and push them as it were before it, while it advances and cuts.

This incision, though not of so general use as that from without inwards, is found very convenient in the opening of large abscesses, when the skin is detached and loosened to a considerable extent.

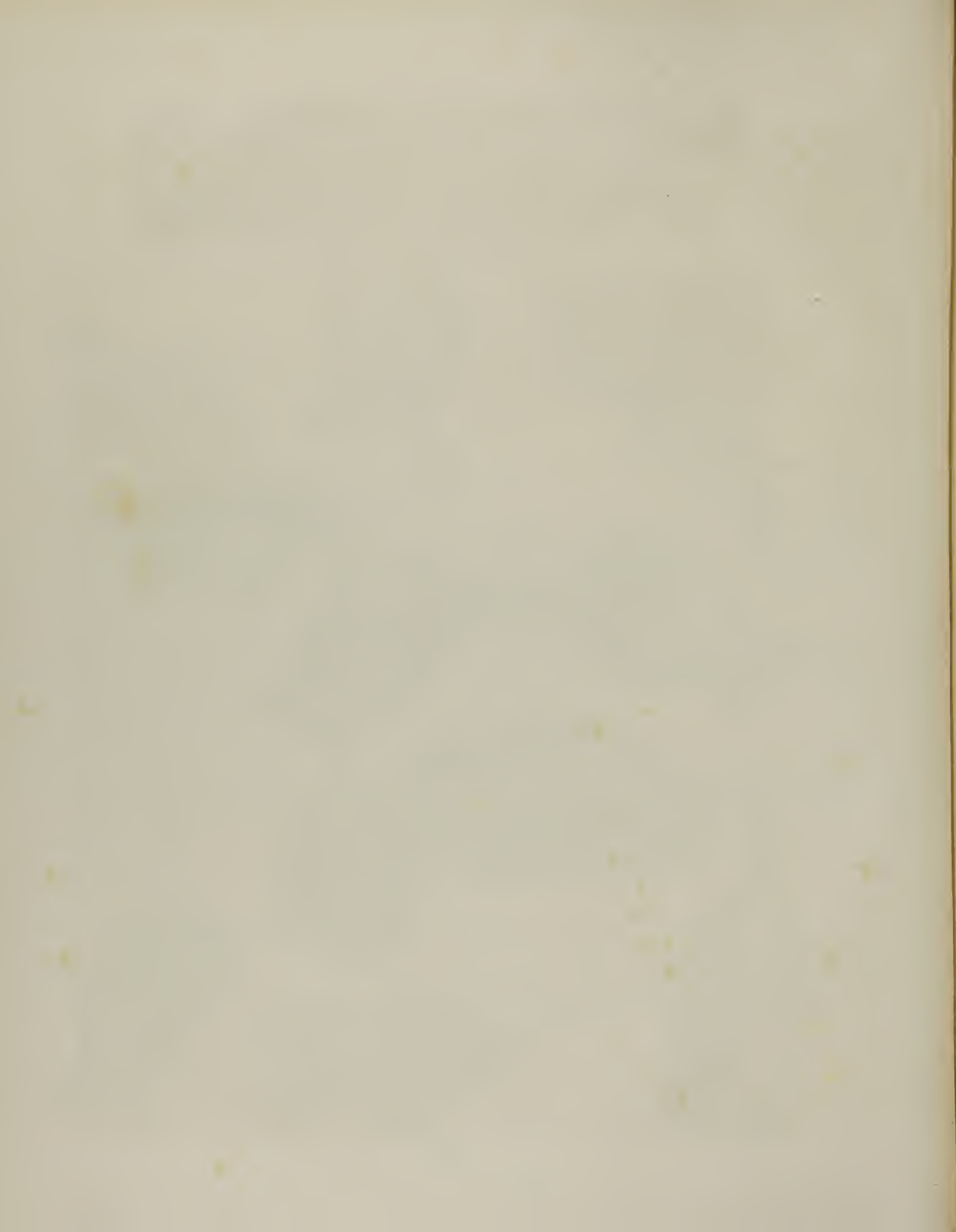
INCISIONS WITH THE BISTOURY UPON A DIRECTOR. (PL. I. FIG. 7.)

The use of a director is very frequently required to guide the action of the knife when it has to penetrate deeply and in the neighbourhood of parts that it is all important to protect from injury. The finger, when it can be employed, is, as has been observed by Dupuytren, a sentient instrument, and the best of all directors; but it is only in some rare instances, where the opening

PLATE II.—POSITIONS OF THE BISTOURY AND SCISSORS.

- Fig. 1.—Position of both hands, one of which makes the integuments tense, while the other, holding the bistoury in the first position, and nearly horizontal, makes an incision on the surface.
- Fig. 2.—Incision with the bistoury held in the *second position*, the cutting edge directed upwards, the left hand of the operator giving a point of support to the instrument, and at the same time making the skin tense.
- Fig. 3.—*Fifth position* of the bistoury; the little finger raised.
- Fig. 4.—*Incision in the shape of the letter T.*
- Fig. 5.—*Crucial incision*, the bistoury in the fifth position in the act of separating one of the flaps.
- Fig. 6.—*Incision from above downwards* upon a fold of skin; bistoury held in the first position.
- Fig. 7.—*Third position of the scissors*; this enables the operator to act with most power in dividing resisting parts with this instrument.
- Fig. 8.—*Second position of the scissors*; employed in making horizontal cuts.





is sufficiently large to admit its introduction, as in the operation for hernia, that we can employ it for this purpose. Under such circumstances we glide flatwise the probe-pointed bistoury along the palmar, and at times even along the dorsal face of the forefinger of the left hand. After the probe point has passed beyond the part to be cut, the edge of the blade is turned upwards, and the division is made partly by pressure with the end of the directing finger, and partly by a sawing motion made with the right hand.

Commonly, however, we have to resort to the use of the grooved director, which is to be introduced through an existing opening, or one made with the knife, and carried below the skin, fascia, or whatever tissue is to be cut. It should be held between the thumb and middle finger of the left hand. The fore finger should be extended upon its back to direct it in its introduction, and after it has entered to the extent required, to serve by being flexed below it, to aid by pressure upward conjoined with a downward pressure of the thumb upon the outer end, in elevating the part under which the instrument is passed. The cut is then made by running a probe or sharp-pointed bistoury along the groove, in such a direction as to form with the instrument an angle of about thirty degrees. When the knife is arrested at the end of the director, it is to be brought to the vertical position so as to make the division complete. Both instruments are then removed together, so as to render it certain that all the parts raised on the director have been divided.

The direction of the incision has been described as made from behind forward; but it may be varied at will. In Plate 2, fig. 7, it is shown as made in the opposite direction from before backward, and which, as will be seen, necessitates a change in the relative position of the fore and middle fingers. One important consideration in regard to the use of the director, when we are operating in the vicinity of important vessels and nerves, and which will be hereafter more fully noticed, is that of raising and carefully inspecting the parts which cover it, before applying the bistoury, so as to assure ourselves that it is covered by nothing but what it is proper to divide.

INCISION WITH THE SCISSORS. (PL. II. FIG. 7, 8.)

There are three forms of this instrument in common use; the straight, curved, and angular; all of which are to be alike held, with the thumb in the upper ring, the third finger in the lower ring, and the middle placed in front and below to render the direction steady. The little finger is to be free. The use of the fore finger varies according to the kind of section desired. If a longitudinal cut is to be made, it should be placed below the instrument and immediately in front of the middle finger, so that the two may act in opposition to the thumb. If an incision is to be made flatwise, the fore finger should rest upon the side of the joint, so as to prevent vacillation, as shown at fig. 7. If the parts to be cut are firm and resisting, and the use of the left hand cannot be brought in to the aid of the right, it will be found advantageous to throw the fore finger across the upper branch of the handles, and make it act in opposition with the middle, which is placed on the lower branch as shown at fig. 8. Finally, if we act upon tissues out of view and through a narrow orifice, and when there is a risk of injuring important parts, the fore finger may be introduced as a

guide between the blades, to press out of the way the parts that are to be spared, and to facilitate the section of those which are to be cut. The scissors, as they are ordinarily constructed, cannot be employed well except with the right hand, as the attempt to close them with the left has a tendency to separate the cutting edges from each other.

PUNCTURES.

A puncture is sometimes, as has already been shown, but the first step of an incision. With this exception, and apart from some particular operations, such as bleeding and vaccination, the object of a puncture is either that of exploring the nature of a tumour, or giving issue to liquid or gaseous matters. Punctures are made with three separate instruments; the bistoury, the lancet, and the trocar: these however, in a great majority of cases, may supply reciprocally the place of each other.

Puncture with the bistoury.—This may be made either vertically or in an oblique direction.

For the *direct* or *vertical puncture*, the bistoury should be held in the first or third position, and the blade entered by a sudden motion of the fingers to the requisite depth, which should be previously determined by the fore finger extended upon the back for the first position, and the middle finger upon the side for the third. Direct puncture is frequently employed in the opening of small abscesses, and for drawing blood in some forms of superficial inflammation.

Oblique puncture.—In this the bistoury is held and introduced with more or less obliquity, like a trocar. It is employed especially for the evacuation of fluids which have accumulated to a considerable amount, as in empyema, and congestive or chronic abscesses. The object of making the puncture obliquely is that of preventing the introduction of air into the cavity after the evacuation of the fluid; an object which is accomplished by giving the knife the oblique direction, so as to prevent the internal opening and that of the skin from becoming parallel. The bistoury is to be withdrawn as soon as the matter appears upon its side, and the left hand should be pressed gently over the walls of the abscess so as to keep up a steady flow, and leave no room for the introduction of air. When the contents are sufficiently discharged, the external orifice is to be covered with a compress, and this secured by adhesive straps or a roller bandage. If any shreds of cellular tissue or coagulated lymph block up the passage, they are to be extracted with the forceps or put aside with the probe, without any interruption of the pressure with the left hand.

Puncture with the lancet may be made precisely in the same manner as it is made with the bistoury, and it suits in many cases of superficial abscess equally as well. It is to be held for this purpose nearly in the same manner as directed for phlebotomy.

Puncture with the trocar.—It is important before using this instrument, to see that the stilet slides freely in the canula. It is to be held so that the handle shall be embraced by the last three fingers, and the end rest against the palm, with the thumb applied at the union of the canula and handle, and the fore finger carried forwards on the instrument so as to limit the depth to which it penetrates. In operating, it should be held at first nearly vertical till the point enters the skin, and then be gradually brought to an

oblique position, while it is at the same time pressed forwards by the palm. By this simple manœuvre I find the instrument may be carried in without shock, and with less pain than by the ordinary method of a direct push. When we discover, from the want of resistance and the mobility of the point that it has entered the cavity, the stilet is to be withdrawn. After the fluid is discharged, the canula is also to be removed. This is effected best by direct traction, while with the fingers of the other hand pressure is made upon the surrounding integument to prevent the sides of the puncture being drawn out and irritated by the friction of the instrument.

II. DIVISION OF PARTS BY LIGATURE.

This, which is an ancient process, consists, 1st, in the complete strangulation of parts by a ligature applied round their base, so as to arrest the circulation and produce separation by gangrene; or, 2d, a ligature less tightly applied so as to effect a division by moderate pressure, which occasions the progressive absorption of the part enclosed in the loop. The former is employed commonly in the removal of tumours; the latter method, when we wish the ligature to act both as a means of division and as a seton, so as to excite granulation behind it in order to close up the passage that it cuts. As the ligature in the latter case becomes loose from the absorption of the part within its grasp, it will require to be tightened from time to time.

Various materials have at different periods been employed for ligatures. Those in most common use consist of well waxed silken or hempen threads of various sizes, or leaden, or annealed iron, silver or platina wire.

There are three general rules for the application of ligatures. 1st. To choose a ligature sufficiently strong for the parts to be embraced. 2d. To enclose within a single loop but a moderate thickness of tissue, as the strangulation will be better effected, when the part is large, by the simultaneous employment of two or more ligatures introduced with the needle. 3d. To divide the skin previously with the knife, so as to avoid the pain and irritation which would arise from including it in the loop, except in cases where the part embraced is small or the skin itself is ulcerated or in a state of degeneration. But in tumours springing from mucous membranes, no previous section of the covering is either allowable or required.

There are three processes for the application of the ligature.

1st Process.—When there is but a slight thickness of tissue to divide, we surround it with a thread which is simply to be tied. If it be a conoid tumour, with a broad base, it must be grasped with the fingers, forceps or hook, to prevent the ligature from slipping. If there is but little prominence, or it is necessary to strangulate the part below the level of the skin, as in cases of small subcutaneous aneurisinal tumour, it is necessary to elevate it previously by a pair of needles or pins placed crosswise under its base.

2d Process.—If the pedicle of the tumour be too thick to be effectually strangulated by a single ligature, or we wish to remove the tumour after tying it, without a risk of the ligature slipping off, a double thread should be drawn through the pedicle, and

divided so as to make two ligatures, which are to be tied separately on either side.

3d Process; that of the compound ligature of Mayor.—This is applied in cases of tumours having a broad base and which it is necessary to remove in separate portions. Large needles of steel, untempered so as to admit of being bent to any curve required, slightly dulled at the point, and with an eye either near the point or heel, are employed to pass the ligature. As many of these as will be required are, according to the directions of Mayor, to be threaded with the same ligature, and placed at equal distances upon it. If we wish to strangulate a tumour in three parts, three needles only will be required. The needles are then to be carefully passed through the base of the tumour, entering them upon the side nearest any neighbouring part that it is important to avoid, and facilitating their exit at the opposite side by pressure with the left fore finger. If the eye is at the heel, the needle must be carried completely through; if near the point it is only necessary to push it so far through that the thread may be seized with the hook or forceps, and drawn out so as to form a loop. The needle is then to be withdrawn.

The loops when thus passed are to be cut, and we have as many double ligatures, for the purpose of strangulating separately each portion into which the tumour has been divided, as there have been needles used. The same results, however, may be arrived at by a more simple process—either by carrying a single needle threaded with a double thread the requisite number of times through the base of the tumour, or by employing several separate needles, each threaded with a double ligature.

In cases where the operation is performed for the removal of vascular tumours, there is not usually much hemorrhage, as vessels of much dimension fly before the dulled points of the needles without being penetrated by them. In case, however, hemorrhage should follow, the needles may be kept temporarily in the wound, and after the tying of the separate ligatures another may be applied below the ends of the needles to embrace the mass at its base. If, however, there is at the base of the tumour any large vessel or other important part that it is necessary to avoid, instead of passing below it, the needles should be made to traverse the tumour itself.

Various processes are employed to tighten the ligatures for the strangulation of parts.—If the wire or metallic thread is employed, it is at first usually thrown round the tumour as a free loop. If a leaden wire be used, which is suited to some soft tumours found within the mucous cavities, the strangulation may be effected to the requisite extent by merely twisting the two ends of the wire together. The silver, iron, or platina wire, should be applied through a canula; the double canula of Levet being the one commonly used. The two ends of the wire doubled so as to form a loop at the middle, are to be passed through the two tubes. One end is to be secured by a few turns to the left arm of the instrument, while the other is left long to be grasped by a pair of forceps and drawn as tight as possible after the ligature is applied, and subsequently secured by a few turns round the other arm. The canula and wire loop are usually left to remain for twenty-four hours, when the life of the part embraced, if the strangulation has been complete, is found so completely destroyed that the tumour will fall off subsequently by sphacelation. In cases of

tumour with large base, it may become necessary to leave the instrument for a longer period, and tighten the loop from time to time as it becomes loosened, by unwinding the end from the arm and drawing upon it with the forceps. Vegetable and animal ligatures may also be applied in the same manner through a double tube; and occasionally, as where a large tumour is to be embraced within a narrow cavity, as that of a uterine polypus, it is convenient, as recommended by Gooch, to have each of the canulæ separate, in order to facilitate the application of the ligature, subsequently fastening them together by means of a short sliding double tube.

When the latter class of ligatures are employed, and the tumour is so situated as to be readily reached with the fingers, it suffices to tie them firmly with a common knot. If the pedicle be of much size and very resisting, it will be necessary to tighten anew or reapply the ligature after three or four days, when its hold will be found loosened by the diminution of the part embraced. In some instances the operator may be compelled to renew the ligature three or four times. In order to keep up the progressive constriction of the pedicle without the necessity of changing the ligature, which it is sometimes difficult to do when the tumour is situated within a cavity, different *serre-nœuds* or knot-tiers have been invented. That of *Graefe*, which has been most used, consists of a stalk of steel pierced at its extremity with a hole, through which are passed the two ends of the ligature after the loop has been applied. At the other end is a screw, which can be turned so as to move upward or downwards a mobile slide, upon which the two ends of the ligature are firmly attached. The *serre-nœud of Rodrigue* consists of a number of small balls of wood, bone, horn or ivory, two or three lines in diameter, pierced in the centre and strung like a chaplet of beads on the two tails of the ligature, so as to form a flexible tube. The two terminal balls are, however, pierced with two holes through which go separately the ends of the ligature, so that the loop may be preserved at one extremity and the ends knotted without the knot slipping into the orifices at the other. This would seem to be a convenient means of strangulating a tumour in an irregular or sinuous passage, as the chaplet will conform itself to the existing curves of the part. The apparatus, however, is apt to prove too flexible, and take a spiral form when we wish to render the constriction very firm. To obviate this inconvenience, it has been modified in the following manner by M. Mayor. This surgeon employs the balls only for one-half the length necessary to the instrument, and replaces them for the other and outer half, with an inflexible metallic tube, provided at its free extremity with a sort of windlass or tourniquet, upon which are rolled the free ends of the thread, so as to render the constriction tight. The first ball, that which comes in contact with the tumour, is also modified in shape, so as to present an acute angle in order to render the cutting action of the ligature perfect over the whole part embraced in the loop. The application of this *serre-nœud* may be seen in the plate displaying the operations upon the tongue.

Effects of the ligatures—If the pedicle of the tumour is not above eight or ten lines in diameter, it is easy to close the loop so tight as to immediately intercept all circulation. The tumour should be covered with charpie or lint to absorb the fluids that are discharged while its separation is going on.

When the constriction is complete, all sensibility ceases in the

part enclosed. The tumour, which is at first swollen after strangulation, shrivels after a time, takes a livid gangrenous hue, and comes away at length in a state of putrefaction in a period varying according to the size and firmness of the pedicle, from a few days to several weeks, leaving a wound with a raw surface. If vessels of considerable size enter through the pedicle, they are sometimes found to resist the strangulation, and require to be snipped with the scissors after the other constituents of the pedicle are detached. Their cavity is usually found obliterated under such circumstances; if such should not be the case, it would be necessary to tie before dividing them. When in the constriction of a resisting pedicle the ligature is not drawn sufficiently tight to obstruct the circulation in the artery, though it may occlude the veins, the tumour will swell from the accumulation of arterial blood, and be the source of severe local pain and great sympathetic disturbance. If we cannot, by drawing on the ligature, effect complete strangulation, it may become necessary to relax or even remove the ligature for a time. If a nervous trunk be included, or the irritation be so great as to excite spasm, or involve a risk of tetanus, the removal of the ligature becomes still more obligatory. In many instances, where the point of operation could be readily reached, I have been enabled to remove these symptoms by puncturing or even excising a portion of the tumour, so as to allow some of the fluids to escape, and subsequently drawing the ligature tight. Conjoined with these local measures of relief, great advantage will be derived under such circumstances from the administration of opiates and diaphoretics.

III. PHLEBOTOMY, OR BLOOD-LETTING IN GENERAL.

The opening of the superficial vessels for the purpose of extracting blood, constitutes one of the most common operations of the practitioner. The principal results, which we effect by it, are 1st. The diminution of the mass of the blood, by which the overloaded capillary or larger vessels of some affected part may be relieved; 2. The modification of the force and frequency of the heart's action; 3. A change in the composition of the blood, rendering it less stimulating; the proportion of serum becoming increased after bleeding, in consequence of its being reproduced with greater facility than the other elements of the blood; 4. The production of syncope, for the purpose of effecting a sudden general relaxation of the system; and, 5. The derivation, or drawing as it is alleged, of the force of the circulation from some of the internal organs, towards the open outlet of the superficial vessel. These indications may be fulfilled by opening either a vein or an artery. To the former system of vessels it is, however, except in cases of emergency, usually restricted. Formerly it was the custom to bleed from a great number of veins, as those on the back of the hand, the temporal, the frontal, the angularis oculi, the ranina, dorsalis penis, etc.; as well as from those of the bend of the arm, the ankle, and the neck, which are the only veins that are now usually opened.

VENESECTON AT THE BEND OF THE ARM.

Surgical anatomy.—The veins at the bend of the arm are situated between the skin and the deep-seated brachial aponeurosis,

in the midst of the fatty cellular tissue which separates these parts. In children, females and obese adults of the male sex, the accumulation of adipose matter is, mainly, in front of the veins, rendering in many cases their location obscure, and but faintly indicated to the touch, as soft elastic rolling cords. But in a majority of subjects they are obvious to the eye, and stand out in relief on the arm. There is such great variation in regard to the size, number and course of the superficial veins of this region, that we scarcely find two individuals in whom they are exactly the same. Even in the arms of the same person they are very commonly found to vary. The veins as they come up from the forearm may, however, be arranged into three classes. 1. Those from the outer side of the forearm and hand, which usually form a trunk, passing over the outer side of the elbow joint, called the superficial radial. 2. Those from the inner and back part of the forearm and hand, forming on the same side of the elbow the superficial ulnar vein. 3. Those which come up on the middle and front part of the forearm, and form, by their union near the middle of the bend of the arm, the superficial median, which shortly after its formation divides into two branches like the letter Y.* One of these branches, called the *median cephalic*, runs obliquely outward across the bend of the arm, to join the superficial radial, and forms with it the common trunk called the *cephalic vein*, which runs up along the outer side of the arm, and passing between the deltoid and great pectoral muscle, opens into the axillary vein, just below the clavicle. The other branch, called *median basilic*, crosses to the inner side of the arm and joins with the *superficial ulnar*, to form the proper *basilic vein*, which empties into the brachial at a varia-

* Very frequently this median vein does not branch but runs inwards as a single trunk to join the ulnar. Occasionally it will be observed running outwards, in the same manner to join with the radial.

ble distance above the elbow. From the deep-seated radial vein which accompanies the artery of that name, there is an anastomosing branch (*vena communicans*) which traverses an opening in the deep fascia at the outer side of the tendon of the biceps muscle, and discharges into the median vein just before its bifurcation, thus increasing the amount of blood that flows through this vein. Occasionally it opens into the median basilic.

There are, therefore, five superficial veins at the bend of the arm, either of which may be opened in venesection; the radial, the ulnar, the median and the two branches of the latter—the median cephalic, and median basilic.

The superficial radial and ulnar, are usually the smallest of the whole, and are so surrounded with branches of the cutaneous nerves, especially the ulnar, (see Plate 3,) that they should not be selected for the operation, except in cases where the other veins are either wanting, or cannot be felt. The radial under equal circumstances, though it does not bleed so freely, is to be preferred to the ulnar, as the latter cannot be opened without risk of injury to the nervous filaments that cover it in front, which though not so serious an accident as formerly supposed, it is desirable to avoid. As the nerves run nearly parallel with these veins, the risk of injuring the former will be diminished by making the opening with the lancet, parallel with the course of the vessel. A slightly oblique cut is, however, usually preferred even here, as it is found to give blood in a larger stream than one exactly parallel. The median vein is occasionally opened below its place of division: while yet deeply situated in the interstice between the mass of muscles of the two sides of the forearm, it is surrounded with nervous filaments, and has the brachial artery placed below it, and so near, especially in thin subjects, that there is some risk of wounding that vessel. But when it lies on either

PLATE III.—PHLEBOTOMY—BLEEDING FROM THE ARM AND FOOT.

Fig. 1.—The right arm is here represented, prepared for the operation at the bend of the elbow. The circular ligature (*a*), knotted upon the anterior and outer face of the limb, has caused a distension of the superficial veins below, which are here shown as they are found existing in the greater number of cases: (1), the median basilic; (2), the median cephalic; (3), the anterior radial or common median; (4), the posterior radial, and (5), the anterior ulnar. The thumb (*b*) of the left hand of the operator is applied on the common median vein, so as to keep its branches full, while the lancet is introduced as seen at (*f*); the incisions (*d, e, g, h,*) represent the other points for puncture, as well as the different directions in which the opening may be made, with least risk to the patient.

Fig. 2 and 3, exhibit the surgical anatomy of the elbow, in reference to the operation. In *fig. 2*, the veins, absorbents, nerves, and the superficial fascia with its adipose layer, are exposed by the careful removal of the skin, bringing into view the aponeurosis of the arm. In *fig. 3*, a portion of the aponeurosis is removed in addition, all the superficial veins with the exception of the median basilic being preserved. The bicipital aponeurosis is seen projecting a little above the lower line of section. In regard to the vein and the different points for bleeding, the same references apply as for *fig. 1*. (6), *fig. 2*, indicates the principal group of the absorbent vessels of the arm; (7), *fig. 2 and 3*, the branches of the external cutaneous nerve; (8), the internal cutaneous nerve; (9), a cutaneous filament of the ulnar nerve; (10), the brachial artery; (11), the satellite veins; (12), the median nerve.

BLEEDING FROM THE INTERNAL SAPHENA.

Fig. 4, shows the manner of bleeding in the internal saphena vein. (1), A prominence formed by the internal saphena, which is a continuation of the external vein of the foot (2). The left thumb of the operator (*b*) fixes the vein on the malleolus to prevent its rolling, while with the right hand the surgeon opens the vessel. In the figure (*d*) below, the lancet is held in the proper position for making the puncture for blood-letting.

Fig 3

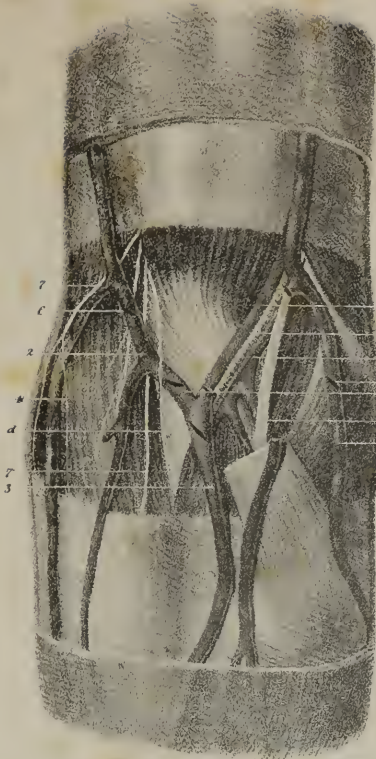


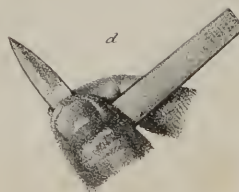
Fig 2



Fig 1



Fig 4



side of this interstice or can be carried there by pronation of the hand, or pressure with the thumb, it may be bled in with impunity.*

The two branches of the median are those commonly punctured in venesection. The *median basilic* is generally the largest, most superficial and most constant, and the one which we are very often compelled to open, in the absence of others of sufficient size. It is the only one, however, which requires great precaution on the part of the operator. In its oblique course to join the ulnar, it rests on the aponeurosis of the biceps tendon, which alone with some thin layers of fatty cellular tissue separates it from the brachial artery. The vein sometimes exactly covers the artery, sometimes is placed at the margin but parallel with it, but more usually it varies a little from the same direction so as to cross it obliquely. It is surrounded with some filaments of the internal cutaneous nerve, one or two of which pass diagonally over it, in the inner half of its course. When we bleed in this vessel, it is best to select the first or lower part of its course, since the artery, as it descends, separates from the vein to get under the muscles of the forearm. When the vein runs parallel with the artery, the hand should be strongly pronated, so as to sink the tendon and aponeurosis of the biceps by partially winding the former round the radius, and thus increase the distance between the artery and the vein while at the same time the supinator longus muscle is brought in front of the tendon, and pushes the vein upon the inner edge of the pronator teres. If the muscles are thin, a slight flexion of the forearm will aid in producing the same effect. Across the middle of the median basilic the greater part of the absorbent vessels of this region pass. These in certain subjects are prone to inflammation, and present another objection to those already mentioned, against bleeding in the middle part of the course of this vein. At its place of junction with the ulnar vein the median basilic covers the great median nerve.

The *median cephalic* may be opened with safety in any portion of its course, as there is not, except in cases of anomalous distribution of the arteries, any part of importance near it except the external cutaneous nerve, which crosses somewhere in the inferior half of the vein but at some little distance behind it. This vein, when of good size, is to be preferred in all cases for the operation. But it is often small or imperceptible, and sometimes deficient, and notwithstanding the objections urged, we are often compelled, as before observed, to resort to the median basilic, as the only vein at the bend of the arm, in which we can succeed in drawing blood in a full current.

Operation.—The points at which the veins may be opened are seen at Plate 3, fig. 1. If at the most favourable spot for the operation, the scars of several previous bleedings are observed, it has been recommended by Dionis and Boyer to make the puncture just below, lest the vein should be found narrowed or obliterated. But this is not a result met with, except there have been twelve or fifteen or twenty punctures near the same place; and except this obliteration has taken place so as to transform the vein into a fibrous cord, it answers perfectly well to make the incision over the old cicatrix. The apparatus required for venesection consists of a bandage for compression an inch and a half

wide and a yard long, a thumb or spring lancet, a vessel to receive the blood, and a separate bandage and compress to secure the wound. The operator should first examine on the inner side of the tendon of the biceps, for the pulsations of the brachial artery, so as to form an opinion of its direction and depth. He should also feel in the neighbourhood of the different veins, whether or not there be any anomalous and superficial distribution of the ulnar or radial arteries, which sometimes occurs where the division of the main trunk has taken place high up in the arm. This should be done previous to the application of the ligature, which would stop the pulsation in the superficial artery, and render it readily mistaken for a turgid vein. This caution is not useless. In two instances I have been called to operate for false aneurism, caused in a superficial artery, by careless venesection. The ligature should be placed as seen in fig. 1, sufficiently tight to cause the veins to fill, but not check the circulation of the artery. The arm is then to be allowed to hang down for a few moments till the veins are sufficiently distended. If they do not quickly fill, the fingers are to be worked, friction made upwards along the arm, or the hand immersed in hot water.

Bleeding with the thumb lancet.—If the right arm is the one selected, the operator places the hand of the patient under his left arm-pit, and secures it firmly against his chest. With the palm of the hand of the same side he embraces the elbow; the thumb and the fingers appearing on the opposite sides of the joint. Some slight friction being made upwards with the little finger of the right hand, so as to distend the vein, the left thumb is to be suddenly depressed, in order to retain it in the distended state. The spear-pointed lancet held as seen at fig. d, is then passed with firmness and precision obliquely on into the vein, until we see the blood beginning to ooze by its side. The smaller the vein, the larger is the opening to be made. If the vessel be deep, it is necessary to enter the lancet more or less perpendicularly for fear of missing it altogether. By elevating the point of the lancet before drawing it out, we may enlarge the opening, as will be required if we intend to bleed freely. The compression made by the left thumb is to be relaxed, and the blood allowed to flow when the bowl is properly disposed for its reception. Care is also to be observed during the flow of the blood, that the arm does not much change its position, so as to produce a want of correspondence between the opening in the skin and vein, causing a subcutaneous effusion of blood known as thrombus or ecchymosis, which often becomes subsequently painful when the tumour formed by it is large. Sufficient blood having been drawn, the ligature is to be removed, the arm partly flexed, and the orifice carefully closed and secured with the compress, and figure of 8 bandage. If adipose matter protrude between the lips of the incision, it is to be pressed backwards, or if that will not suffice clipped away, so as to allow the edges of the skin to come together, in order to insure union by the first intention. If the vein has been many times bled in, and has become thinned in its walls and varicose, there is sometimes a difficulty in arresting the blood. But a more methodical compression, effected by the aid of some small graduated compresses, secured with a nodose bandage reversed over the wound, will be found to answer. The arm should be worn in a sling for twenty-four hours, by which time the puncture is usually closed: the compress may be removed on the third day.

* In case of need, even, the cephalic vein may be opened just above the bend of the arm.

Bleeding with the spring lancet.—The thumb lancet, if in proper order, is by far the surest, safest and neatest instrument for venesection. But in this country, and the north of Germany, the spring lancet, or phlebotome, is more commonly employed, in consequence of the greater facility with which it is kept in order, and because bleeding with it is found so easy that little skill or experience, in ordinary cases, suffices for its use. In using this instrument the blade is to be fixed, so as to strike at such a depth, as by calculation will divide the skin, cellular tissue, and anterior wall of the vein. As there is a chance, however, that the blade may penetrate the posterior wall of the vein, and wound the parts beneath, it never should be held in the direction of the artery, or the aponeurotic expansion of the biceps; the mere puncture of the latter being apt to give rise to the inflammatory swelling of the cellular tissue below it, which, when it occurs, prevents for a time the complete extension of the arm, and in cases tending to suppuration requires an operation for the division of the resisting fascia, so as to take away the painful pressure on the swollen part. The cautions above given in reference to bleeding in the median basilic are especially to be observed in the use of this instrument.

VENESECTION AT THE FOOT.

Next in order of frequency, is the practice of bleeding from the *venæ saphenæ*. This is resorted to in cases where it is impracticable to open a vein at the bend of the arm; or, in accordance with the opinion entertained by some practitioners, for the purpose of producing a revulsion in affections of the head and chest, especially when these have followed a suppression of menstrual or hæmorrhoidal discharges. We may bleed either from the internal or external saphena. The walls of these veins are thick in proportion to their calibre, and seldom bleed freely. They are accompanied by nerves of the same name.

The *internal saphena* consists usually of a single trunk, formed by veins from the same side of the foot, runs over the middle front portion of the internal malleolus, ascends on the inner side of the knee joint, and discharges into the femoral vein near the groin. The internal saphenus nerve runs on the inner margin of this vein, and sends branches across it below the malleolus. It is therefore at the upper or middle part of the ankle bone, and on the posterior part of the vein, that we make the puncture. The foot should be immersed for a sufficient time in warm water, to cause a distension of the veins. A ligature is then to be placed two inches above the ankle, and knotted on the outer side of the leg. The foot, well dried and inclined on its outer side, is to be taken on the knee of the operator or rested on a chair, and the puncture made with the thumb lancet, the vein being well secured with the thumb of the left hand to prevent its rolling under the instrument. If the spring lancet be used, great care should be taken that the blade does not come in contact with the bone, as it might be broken, and a fragment left in the wound. When the blood ceases to flow, or a sufficient quantity is taken, the vein is to be secured in the ordinary manner.

The *external saphena vein* is usually inferior in size to the internal, and is seldom opened. It runs up behind the external malleolus, where it has the external saphenus nerve lodged in a distinct sheath at its posterior border, and empties into the pop-

liteal vein just above the knee joint. The ligature should be placed a little higher than for the preceding operation. The foot should be rested on its internal margin, and the puncture be commenced near the outer border of the vein, and carried obliquely across so as to avoid the nerve.

VENESECTION AT THE NECK. (PL. IV.)

This is practised exclusively on the external jugular vein. This vein receives blood from the exterior portion of the cranium and face, and is connected by anastomosing branches with the sinuses of the brain. It descends in the direction of a line drawn from the angle of the jaw, to the junction of the external third with the internal two-thirds of the clavicle, where it sinks under the edge of the sterno-cleido-mastoid, and opens into the subclavian. The vein is covered in front by the skin and platysma-myoides muscle, and lies on the outer surface of the sterno-cleido-mastoid. At several points, but especially near its middle, it is crossed by some nervous filaments from the cervical plexus. No artery is in its neighbourhood. The place at which it is opened, is, in the adult, about three fingers' breadth above the clavicle, and over the belly of the sterno-cleido-mastoid.

Operation.—The patient is to be placed in the sitting posture, with the head slightly turned backward, and to the opposite side from that in which we bleed; the shoulder should be protected with a napkin. The vein may be made to swell up and become apparent, by pressure with the thumb of an assistant upon it a little distance above the clavicle. It answers better, however, to lay a thick, hard compress on this point, and bind it firmly down upon the vein with a broad ligature or a folded cravat, which should be knotted under the axilla of the opposite side; or the ends of the band may be carried directly round the neck, and held tightly though at some distance apart, so as to compress only the vein, and not interfere with the circulation in the other vessels of the neck. If the vein does not fill well, it will be found advantageous in this respect to cause the patient to move the jaws as in mastication, and make a few prolonged expirations. The same measures will also be found after the vein is opened to facilitate the discharge of blood. The lancet properly opened, and held as seen in Pl. 3, the operator, pressing with the left thumb upon the swollen vein above the compress and with the fore finger of the same hand a little distance higher in order to steady the vessel and stretch the skin, makes a puncture between these points obliquely upwards and outwards, in the direction of the fibres of the sterno-cleido-mastoid, conformably to the directions given for bleeding in the arm. In this case, however, the puncture must be made deeper and the orifice broader. The widening of the orifice may be effected by raising the lancet, after it has well entered the vein, and withdrawing it in a vertical position, carrying it slightly upwards at the same time. This movement divides freely the fibres of the platysma muscle, which might otherwise contract over the orifice and prevent the free discharge of blood; and obviates, even where the vein is most deeply situated, the necessity of a previous division of the skin and muscle with a bistoury, as has been suggested by M. Magistrel. The blood seldom springs in a jet; it usually trickles down the neck, and must be conducted off by a bent card pressed against the

skin. On removal of the compression, the flow of blood usually ceases of itself. The wound is to be closed with a strap of adhesive plaster, and supported with a compress and a few turns of a circular bandage moderately tightened. If, as *occasionally* happens, these measures do not arrest the after flow of the blood, the lips of the orifice may be closed with the hair-lip suture.

VENSECTION NEAR THE PART AFFECTED.

Bleeding in the frontal, or *ranina* veins, for affections of the brain and tongue, are not now practised. In the former it is inefficient, and in the latter there is often a difficulty in checking the flow of blood. But in local inflammation of the hand or foot from arthritic or other causes, or of the external genitals, where the trunks of the veins are kept swollen from the strong determination of blood to the part, local venesection has been recommended by M. Janson and Sir A. Cooper, and has proved in my own practice occasionally useful.

BLEEDING BY INCISIONS FROM THE CEPHALIC. (PL. IV. FIG. E. F.)

When the necessity for the abstraction of blood from the general circulation is urgent, and it cannot be obtained to a sufficient amount from the sources above described, it has been *suggested* by M. Lisfranc, rather than have recourse to arteriotomy, to open the cephalic vein at the upper part of its course between the deltoid and pectoralis major muscles. An incision of an inch in extent is to be made with a scalpel through the integuments and superficial fasciæ covering the groove between these muscles, and the vein, exposed to view by a slight separation of the muscles, is to be punctured with the lancet. The operation is attended with some little difficulty, and opposite the upper third of the deltoid the vein is in company with the deltoid branch of the superior thoracic artery, which would incur some risk of being wounded. It has been proposed by M. Bourguery, (Pl. IV. fig. F.) as easier and safer to open the vein below the insertion of the deltoid, following the plan above given.

IV. ARTERIOTOMY.

Blood-letting for therapeutic effect, is practised only on the superficial arteries, and is but seldom resorted to. The superficial temporal artery, the facial where it crosses the base of the jaw, the occipital above the attachment of the complexus muscle, the radial near the hand, and the anterior tibial on the dorsum of the foot, are sufficiently superficial to be opened with safety if required in a case of urgent necessity, and lie near enough to the bone to admit of the requisite degree of compression afterwards. It is to the first, however, or superficial temporal, that the operation is almost exclusively restricted.

Surgical anatomy.—The main trunk of the superficial temporal artery passes over the zygomatic process of the temporal bone, about a quarter of an inch in front of the auditory meatus, where it may be felt pulsating. As it passes upward it divides, at the distance usually of an inch and a quarter from the middle of the zygomatic arch, into an anterior and posterior branch.

The posterior is distributed to the hairy scalp over the parietal bone. The anterior or frontal branch passes in the direction of the forehead; its position is variable, but it is obvious to the touch, and may often be seen pulsating under the skin. Blood may be drawn from the frontal branch, which is covered only by the integument and a thin layer of fascia: or if this be not of sufficient size, from the main trunk in any point between the zygoma and its place of division. In this part of its course it rests upon the aponeurosis, covering the temporal muscle. On its outer side is a strong layer of superficial fascia as well as integument. The latter is dense and thick, and the artery is invariably found deeper than the sensation given to the finger by its pulsation would seem to indicate. It is accompanied by some nervous filaments from the facial and inferior maxillary nerves. The vein which attends it is small and unimportant. Bleeding in the main trunk should not be undertaken without due consideration, as it has been followed by aneurism, and, in some instances, in order to stop the hemorrhage, it has been necessary to twist or tie the vessel. The best place for the operation on the trunk, is three-fourths of an inch above the zygoma, and an inch and a quarter from the auditory meatus.

Operation.—Whether the frontal branch or the trunk before its subdivision is opened, the processes to be followed are much the same. A bistoury is to be preferred to the lancet for opening the resisting skin. The face is to be turned toward the opposite side, supported by an assistant, or inclined upon a pillow if the patient is in a horizontal position.

1. *Process of the author.*—A fold of skin about half an inch broad is to be raised above the vessel, and divided by a straight sharp-pointed bistoury, passed through its base in a direction somewhat oblique to the artery. If no other instrument be at hand, the section may be made with the thumb lancet. The lips of the wound are to be separated with the thumb and fore-finger of the left hand; the artery is to be laid bare with a few strokes of the point of the instrument, and punctured obliquely like a vein. The requisite amount of blood having been taken, the artery should be compressed with the finger below the wound and divided completely across. The retraction which follows usually stops the hemorrhage. The wound is then to be closed with two or three narrow adhesive strips, and secured with a double compress and roller. If the discharge is not immediately arrested, a compress should be placed above as well as below the section, in order to prevent the return of blood by the anastomosing vessels. If the artery be large, a ligature for greater security may be placed upon it, or, which will usually suffice to stop the blood, the wound may be closed with a stout hare-lip suture.

2. *Usual process.*—The position of the artery being marked with ink, and the skin made tense above it with the thumb and index finger of the left hand, the artery is divided completely across with the convex-pointed scalpel, which should be pressed downwards directly upon it with the fore-finger upon its back till it meets the bone, and then drawn slightly towards the operator.

3. *Process of M. Magistrel.*—The artery being steadied with the middle finger of the left hand, a quarter of an inch above the place at which it is to be divided, a straight sharp-pointed bistoury, with the edge upward, is passed directly down to the temporal aponeurosis, upon one side of the artery, and glided obliquely

under it by lowering the handle. The instrument is then to be raised to the vertical position, dividing the vessel across, and enlarging to the extent of six or eight lines the orifice in the skin as it is withdrawn. The track of the wound should lie rather obliquely across the course of the artery. The operation is as rapidly done as venesection at the arm. If there is difficulty in arresting the bleeding, or the patient through delirium tears away the dressings, the diagonal direction of the wound permits of the application of a suture with a curved needle which shall enclose the two ends of the vessel and effectually stop the blood. The only objection to this and the preceding process is, that the retraction of the divided vessel will often check the discharge before the requisite amount of blood is obtained.

V. CAUTERIZATION.

Cauterization consists in the application to the living tissue, of agents capable of disorganizing the parts with which they come in contact. They are divided into two classes, distinguished by the names of *potential* and *actual* cauteries. The *potential* cauteries have received their names because they possess inherently this property of disorganizing the tissues; while in the *actual*, it

is owing solely to the caloric with which they are charged for the occasion, so as to render the effect instantaneous, or *actual*, in the acceptance of this word by the older writers, from whom this classification is derived.

1. *Of potential cauteries.*—The articles of this class are very numerous, and are found in the *solid*, *soft*, or *liquid* state.

Solid.—These comprise crystallized potash and soda, nitrate of silver, dento-chloride or butter of antimony, minium, calcined alum, white or deutoxide of arsenic, deutoxide of copper, deutochloride and red oxide of mercury, powdered savin leaves, etc.

Soft.—These consist of the solid caustics pulverized and diluted with cerate, honey, alcohol, or water, so as to form a soft paste that may be spread upon the diseased parts. Of this description is the ammoniacal ointment of Gondret; the paste of chloride of zinc employed by Canquoin, the arsenical paste of Dupuytren and Rousselot, that of oxalate of potash prepared from the leaves of the wood sorrel, etc. etc.

Liquid.—These are very numerous, consisting, as they do, of all the concentrated acids, especially of the nitric, sulphuric, and hydrochloric; the saturated solution of the solid caustics, such as the acid nitrate of mercury, butter of antimony, chloride of zinc, corrosive chloride of mercury, sulphate of copper, etc. etc.; and finally the lately devised caustic of M. Recamier, which consists of a solution of the chloride of gold in *aqua regia*, in the propor-

PLATE IV.—ARTERIOTOMY—BLEEDING FROM THE JUGULAR AND CEPHALIC VEINS.

BLEEDING FROM THE TEMPORAL ARTERY.

- (A.) *Bleeding from the frontal branch of the temporal artery according to the old process described by Boyer.*—An incision with the straight bistoury is represented as made directly across the course of the vessel so as to divide it. Two small graduated compresses are placed across parallel with the lips of the wound, to show the manner in which compression is to be made, after a sufficient amount of blood has been taken. A roller bandage is then applied over these compresses.
- (B.) *Incision of the trunk of the temporal artery above the zygomatic arch.*—If the cut is made transversely from a point above the zygomatic arch and in front of the concha and antitragus, the artery may be always neatly divided across. As there is a solid bony surface below, the hemorrhage may be arrested at will with a compress and knotted bandage, unless it is preferred to close the wound with a hare-lip suture, or tie the vessel as mentioned in the text.
- (C.) *Bleeding from the artery by the process of M. Magistrel.*—The knife shown raised towards the vertex as in the last stage of the operation.

(D.) BLEEDING FROM THE EXTERNAL JUGULAR VEIN.

A graduated compress (*a*) is placed in the fossa above the clavicle; a band (*b*) is laid with its middle over the compress and the ends passed diagonally under the armpit of the opposite side. The finger of one hand is seen compressing the vessel so as to cause it to fill up, while it is opened with the instrument in the other. The mode of compression, as advised in the text, will however be found preferable.

(E. F.) BLEEDING FROM THE CEPHALIC VEIN OF THE ARM.

- (E.) represents the place for the previous incision to expose the vein, as advised by Lisfranc, in cases where blood cannot be got from the bend of the arm, the back of the hand, the foot, or the jugular.
- (F.) Bleeding from the cephalic below the tendon of the deltoid, as recommended by Bourguery. It is made in the groove, found in front of the triceps and brachialis anticus, and behind the external portion of the biceps. A compress and band (*c*) is applied to fill the vein and prevent the introduction of air.



tion of six grains of the salt to an ounce of the mixture of nitric and hydrochloric acids.*

APPLICATION.—Most of these caustics are employed according to special indications, which, from the limits of this work, can only be partially noticed. The nitrate of silver or lunar caustic is employed particularly for the purpose of limiting the spread of erysipelas, repressing fungous granulations, exciting action in old wounds or ulcers, cauterizing the surface of diseased mucous membranes, for destroying the nature of primary chancres, &c. Caustic potash is resorted to for the purpose of forming issues, opening abscesses, and for the rapid destruction of tissue when this measure becomes necessary in scrofulous, and some other analogous affections. The arsenical paste is principally employed for the cure of superficial and corroding ulcerations; chloride of zinc in cases of deeper seated cancerous affections; chloride of antimony for the purpose of cauterizing poisonous wounds; powdered savin leaves, alone or combined with the deutoxide of copper, for the removal of syphilitic vegetations.

Application of the liquid caustics. If the liquid caustics are used, and especially the acid nitrate of mercury, (which enjoys a high reputation in ulcerous affections of the *os tincæ*, and where of course it is only to be applied through a speculum,) they must be laid on with a small brush, or a pledget of lint dipped in the solution and pressed on the diseased surface. If the part to be removed is of considerable thickness, several applications may be required at one sitting, carefully removing at each time the substance destroyed by the previous touch, so as to lay bare a new surface;—the operation done, the caustic is to be wiped or washed away from the part. The action of these caustics is rapid—almost instantaneous; and a principal objection to their use is the difficulty of limiting their action to the affected part; this in some superficial situations may, however, be readily accomplished by forming a little bank round the diseased structure with basilicon, or any other adhesive ointment. The colour of the eschar formed by nitric acid is yellow; by sulphuric acid, black; hydrochloric, greenish. The butter of antimony forms at the instant of its contact with the tissues, a thin, dry, flocculent, flaky and shining eschar, which may if necessary be removed immediately in order to renew the application. The acid nitrate of mercury also forms a dry solid eschar, which is of a yellowish or brownish colour. A great advantage attending the use of this caustic, shared to a certain extent by the arsenical paste, is the promptness with which it is followed with cicatrization. The acid solution of the chloride of gold used by Recamier, if experience should confirm the allegations in its favour, ought to obtain the preference over all other forms of liquid caustics. It forms a neat, well-circumscribed eschar, which comes away at the end of three or four days, and unlike the two last mentioned, does not appear to have ever been followed by absorption, so as to make a poisonous impression on the general system.

Application of some of the soft caustics.—The ammoniacal ointment of Gondret consists of equal parts of lard and concentrated ammonia. It is very volatile, and should, therefore, be prepared instantaneously. It is spread upon linen in a layer half a line thick. In a few minutes it will produce vesication; at the end of

a quarter of an hour, or a little more, a superficial eschar is formed, though in some instances, in order to produce this effect, it is necessary to renew the layer. It is more commonly, however, employed as a rapid epispastic than as a caustic, and its place may then be supplied by the simple concentrated ammonia confined under a pill box or something similar, or by the antidynous lotion of Granville, of which ammonia is the chief constituent.

Arsenical paste.—This has long been employed by the profession, and with empirics is a favourite remedy for all cancerous affections. There are several forms of the paste well known, which differ from each other only in the proportion of the arsenious acid which they contain. That of Frère Come and of Rousselot consists of two parts of arsenious acid, thirty-two of the sulphuret of mercury, and sixteen of dragon's blood. The caustic *pommade* of Hellmund contains three-quarters of a grain of the acid in ten drachms and a half of the excipient. The following, however, will be found one of the most safe and convenient forms for common use: Take of the arsenious acid from four to six grains finely comminuted, one drachm and a half of calomel, and three drachms of powdered gum Arabic: triturate these well together, and add as much distilled water as will form a soft paste. After preparing the surface of the diseased part—by removing any crust that may cover it, or excising the top—wait till the bleeding is checked, and while the surface is still humid, apply a layer of the latter mixture from a third to half a line thick. The paste should extend a little beyond the bounds of the disease, and be covered either with some scraped lint, or with spider's web, and the whole well secured with a bandage. A sharp burning pain, and some œdematous swelling follow. In six or eight days the paste separates spontaneously, and the slough comes away in about as many more. From four to six applications of this description will suffice usually in effecting the desired organic changes in the part. Many superficial cancerous affections, and it is alleged even bleeding (not medullary) fungus, may be cured by the employment of this formula. It produces a livid coriaceous eschar, excites actively the surrounding vessels, determines a peculiar alterative effect in the subjacent textures, and is followed by the singular phenomenon of a more or less copious effusion of coagulable lymph after each application. Over an extensive surface the application of this caustic paste would be attended with danger; it has been followed under such circumstances with symptoms of poisoning. In many cases of long standing and deeply corroding lupus ulceration, M. Cazenave has recently strongly recommended the following formula for the arsenical paste: White oxide of arsenic, two parts; sulphate of mercury, one part; animal charcoal in powder, two parts. A small quantity of this is made into a paste with a few drops of water, and applied upon the denuded surface. The surface covered should never, however, exceed in extent that of a franc piece, for fear the arsenic might be absorbed to such an extent as to give rise to serious constitutional symptoms. The application is attended with pain and some erysipelatous swelling. A hard, brown crust is formed, which often adheres for nearly a month before it is detached.

Phagedenic paste of Canquoin. (Chloride of Zinc.) This is an energetic and unfailing caustic, the application of which is attended with severe pain, persisting with great intensity for the first seven or eight hours. It is free from all risk of absorption,

* For the formulæ for the preparation of most of these articles, see Wood & Bache's Dispensatory, and Dunglison's New Remedies.

seldom gives rise to much surrounding inflammation or swelling, except it be applied where there is much loose cellular tissue, acts to a depth which may be calculated with considerable precision in advance, and is said to be valuable in most instances where the surgeon's hand can reach. It was introduced into practice by M. Canquoin, and has been pretty extensively used by many individuals, for cancerous and other malignant diseases. In order that the caustic may act with efficacy, it must be employed in a concentrated state. In solution it merely acts as an irritant. From its extreme deliquescency it is necessary to mix it with some substance of a counteracting tendency. M. Canquoin employed wheat flour. Dr. Ure has lately suggested the use of anhydrous gypsum instead of flour, as it does not, like the latter, form a glutinous dough which has a tendency to blunt the action of the acid, but a porous medium through which all the particles of the deliquescent chloride may arrive upon the diseased surface.* The same writer believes that the chloride of zinc acts in virtue of its powerful affinity for albumen, which in a state of development forms the principal bulk of cancer. The proportion in which the caustic is mixed with its excipient has been much varied. M. Bureaud employs an equal portion of the two substances. Velpeau doubles the proportion of the chloride. But the proportions of Canquoin are usually considered the most advantageous; these are found in the following formulæ. *Paste No. 1*:—Chloride of zinc, one part by weight; wheat flour, two parts.

* London Med. Gazette, vol. xviii.

This employed in the form of a paste four lines thick, is capable, if applied during ten days, of producing an eschar an inch and a half in depth. If three lines thick, it will cause during the same period, an eschar one inch in depth. If but two lines thick, it gives an eschar half an inch in depth. A layer of one line in thickness yields in twenty-four hours, an eschar of three lines; and one of half a line thick, in the same space of time, will produce an eschar of at least a line. *Paste No. 2*:—This consists of chloride of zinc, one part; wheat flour, three parts; and is employed usually in painful cancerous affections. The depth to which it will act in a given time may be readily calculated, from what has been observed in regard to the action of *Paste No. 1*. *Paste No. 3*:—This comprises one part of the chloride, and four of the flour; and is used only in very delicate and irritable subjects. *Paste No. 4*:—This is formed of one part of the chloride of zinc, half a part of the chloride of antimony, and two and a half parts of wheat flour. It is to be moulded into a crayon shape; it preserves always the consistence of soft wax, and a suitable thickness may be given to it so as to adapt it to uneven and nodulated surfaces.

In preparing the phagedenic paste, thirty or forty drops of water are to be added for each ounce of the chloride. The salt is to be reduced to a fine powder, and mixed as quickly as possible with the given quantity of flour. One-half of the mixture is at first to receive its given proportion of water, and worked up with a spatula, gradually adding the other half, till it forms a tena-

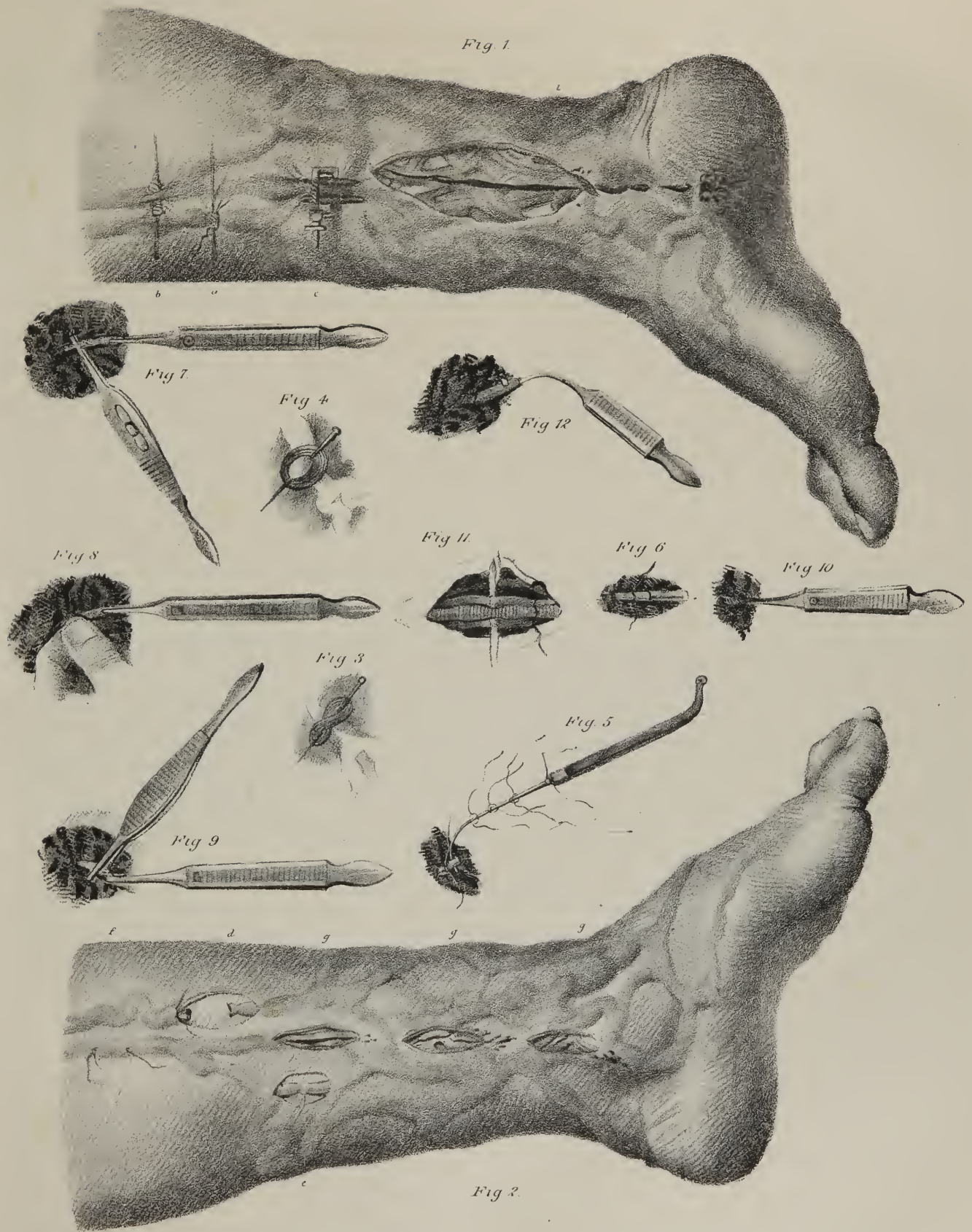
PLATE V.—OPERATIONS UPON THE BLOOD-VESSELS.

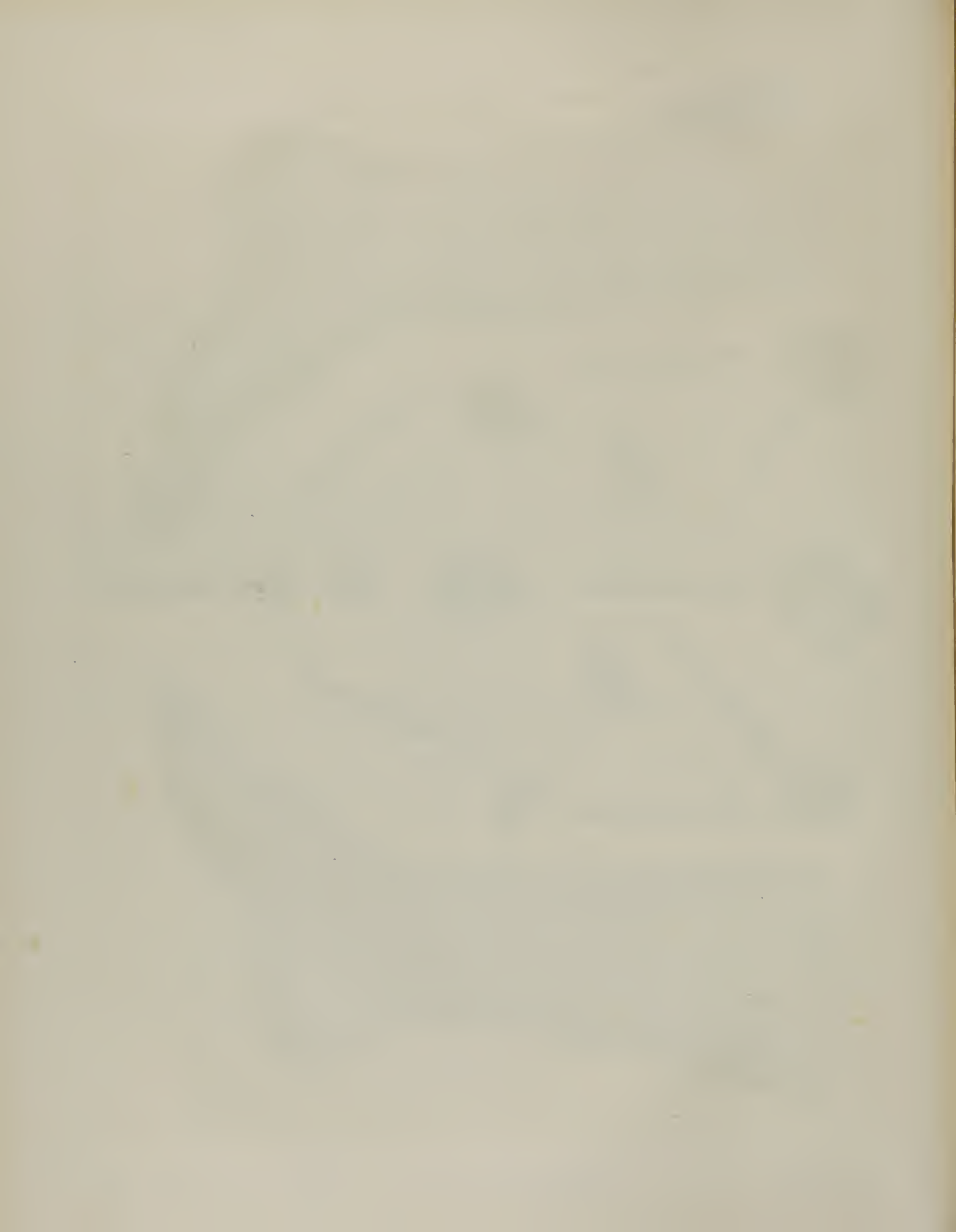
VARICOSE VEINS.

- Fig. 1. (a, b, c).—Compression of the principal veins above the varices.*—*a.* A needle and twisted suture applied according to the process of M. Davat, upon a branch of the internal saphena vein.
b. Modification of Velpeau, by the vertical rolling of two threads upon the sides of the needle, next the two places of puncture.
c. Compression with the forceps or double plates of Sanson; the closure of the plates being effected with the screw.
d. Longitudinal incision of a mass of enlarged veins, according to the process of Richerand.
Fig. 2.—*d.* Ligature with excision of a portion of the vein.
e. Temporary ligature with a slip knot after the manner of Wise.
f. Suture or seton: Process of Fricke.
g, g, g. Operation upon the vein by a series of separate incisions.
Fig. 3.—Process of Davat more distinctly shown.
Fig. 4.—Modification of this process, by making circular instead of figure of ∞ turns, to which the author gives the preference. A number of these sutures are usually required, so as to obstruct the enlarged veins at several points.

CLOSURE OF THE MOUTHS OF ARTERIES DIVIDED BY A TRANSVERSE CUT.

- Fig. 5.*—The end of the artery is seen drawn out with the tenaculum, and the ligature knotted above. Several loose ligatures are placed on the tenaculum, for the purpose of tying the vessels in succession without loss of time; a method, however, but little practised.
Fig. 6.—Ligature of the artery upon a foreign body introduced into its cavity.
Fig. 7.—Process of Amussat (*par refoulement*). The artery is compressed firmly with one pair of forceps, and its two inner coats doubled backwards or stuffed into its cavity with another pair, narrow and rounded near the point.
Figs. 8, 9, 10.—Torsion of the arteries, by different processes.
Fig. 11.—Strip of kid skin passed as a seton through the artery.—Process of Jameson.
Fig. 12.—Closure of the mouth of the artery by the process of Stilling.





cious paste capable of being rolled out into cakes or wafers from half a line to four lines in thickness. If the integuments are sound, it is necessary, before applying the paste, to remove them the day previous with a blister, caustic ammonia, or hydrate of potash. M. Canquoin, in cases of tumours, makes one, two, or three applications of the Vienna caustic paste, at intervals of twenty-four hours, placing the zinc paste over the last eschar formed.

When time has been allowed for the operation of the zinc paste to be complete, it is taken off, and the part covered with emollient poultices until the eschar separates, which usually takes place, as has been already observed, from the eighth to the twelfth day. The application of the caustic is in this way to be repeated again and again, till the whole morbid structure is removed. When frequent repetition is required, M. Canquoin alternates with it the use of the Vienna caustic.

The *bichloride of mercury or corrosive sublimate*, which like the chloride of zinc has a strong affinity for albumen, has in some instances been likewise employed in the form of paste; but from its poisonous nature its application should be limited to small surfaces only, for fear that the poison might enter the circulation. The preparation used at times by Græfe for the destruction of erectile tumours, consisted of two drachms of the sublimate, with two scruples of powdered gum Arabic, and as much water; the eschar which it leaves is soft, white and thin, and separates in two or three days. A weaker paste formed of two parts of gum Arabic to one of the sublimate, has been found in some instances to promote the cure of herpetic or carcinomatous ulceration attacking the eyelids. By making a longitudinal cut in the skin, and rubbing into the fissure some of the dry pulverized sublimate, a small issue may be very neatly formed. In the state of strong solution,—a scruple to an ounce of water, M. Ricord has advised its use over the blistered surface of a recent bubo, following chancre in order to render abortive the specific inflammation of the gland. But the practice does not in such cases, as it appears to me, merit the encomium he has bestowed upon it. In the troches of minium,—little conical masses used for the purpose of dilating and at the same time stimulating a fistulous opening,—it forms the chief active ingredient.

Application of some of the solid caustics. Caustic potash or hydrate of potash.—This should be carefully preserved in close-stopped vials, as it absorbs moisture and carbonic acid from the atmosphere so as to be weakened in its effects. It acts by its powerful affinity for the moisture in the animal tissue, which it absorbs so as to produce a rapid softening and decomposition resulting in a slough. It is employed as a crayon, when we wish to effect the speedy removal of a callous or indolent structure, with stimulation of the parts beyond to healthy action. It may be rubbed upon a surface, or insinuated for a moment into the orifices of sluggish or scrofulous abscesses.

Application of solid caustics to the surface for the purpose of forming an issue, opening an abscess, or for the removal of nævi materni.—A piece of adhesive plaster, pierced at its centre with a hole one third of the dimensions desired for the issue, is to be fastened on the surface. In the orifice is to be placed a piece of the crystallized potash, the size of a hemp seed, which will produce an eschar six or eight lines in diameter. If it is desirable to render the eschar an inch across, it is better to augment the

breadth of the piece of caustic, than increase its thickness; for a layer of two lines is quite adequate to destroy the substance of the skin down to the subjacent cellular tissue. Over the orifice which has received the caustic, another piece of adhesive plaster is applied to keep the latter in place, and the whole should be confined with a compress and roller to prevent the risk of its disturbance. An itching and burning heat soon follows. At the end of six hours the effect is complete, and the apparatus may be removed. A black eschar is formed, from which all the uncombined caustic should be removed by ablution. The eschar may then be split by the bistoury, and left to be detached by suppuration under the use of emollient poultices. If it appears disposed after a few days to dry up, rather than become detached, its removal may be facilitated by the application of small blisters over it.

Hydrate of soda, though not so commonly used, is an efficient escharotic, and adapted to the same purposes as the caustic potash; being less deliquescent, it is even more manageable than the latter.

Caustic or quick lime is also occasionally employed mixed with an equal portion of dry soap in the state of powder, and acts by virtue of the same properties as the two preceding alkalies, though less powerfully. Canquoin's formula was three parts of the lime with two parts of the soap, diluted with a little alcohol so as to give it the consistence of pap. It is more frequently used, however, in the following combination.

Caustic potash and quick lime. (Vienna caustic paste.) This is composed of five parts of the potash gradually mixed in a mortar with six parts of the powdered lime, which at the moment of using, is to be converted into a paste, with a few drops of alcohol. It is to be laid with precision upon the part, in a layer of two lines thick, and watched with attention, as it acts promptly. In about six minutes the whole thickness of the skin will be destroyed, which effect is indicated by the appearance of a circular gray line at the circumference of the paste. The caustic is then to be removed, and the wound washed with vinegar and water in order to neutralize the remaining particles of the paste. If we wish to act deeper with the caustic than the whole substance of the skin, as in the case of removing a tumour, it may be left applied fifteen or twenty minutes, but not longer. The sensation produced by this caustic is, like that of all the rest, a burning heat, but the attending pain is infinitely less, and more like that of a blister. Mixed with a little powdered opium and soap, it is still more endurable, though the time of action will be a little prolonged. For the formation of an issue, the removal of a small erectile, or cancerous tumour, I have found it in my own practice to realize all the advantages, with few or none of the inconveniences which attend the use of the common caustic potash. The opinion, however, is commonly entertained, with what positive truth it is yet difficult to say, that in cases of malignant degeneration, it does not to the same degree as the arsenical or zinc paste, take from the part the tendency to reproduce the disease.

CAUTERIZATION WITH THE METALLIC OR ACTUAL CAUTERY, OR SURGICAL PYROTECHNICS. (PL. VI. FIG. 12 to 17.)

Metallic cauteries are usually made of steel, set in a movable handle of wood or ebony, forming the largest bulk at the cauterizing end, which is bent at an angle with the shaft. M. Gondret

proposed, some years since, to use copper in place of steel in the manufacture of these instruments, alleging that, from the capacity of the former for caloric and its great conducting properties, it would convert into an eschar the surfaces with which it was brought in contact, in one-fifth of the time required by the common cautery heated to the same temperature. As yet, however, the use of copper has been by no means general.

There are eight principal forms of the cautery, or searing iron described; distinguished as the *cylindrical*, the *conical*, the *flat round*, the *button-shaped*, or nummular, the *three-sided prism*, the *halbert-shaped*, the *annular*, and the *octagonal*. The two latter, however, are useless, as their place may be always well supplied with one of the preceding forms. The head of the *cylindrical* iron is two inches long, and half an inch in diameter; these dimensions, however, may be varied at will, without altering the proportions of the instrument. Some employ it without being bent at an angle with the shaft. From its great size, it retains caloric for a long time, and is the form chosen, where the parts to be cauterized are thick, humid, or extensive. The head of the *conical* iron is an inch long, and eight lines in diameter at its base; it is only applied at the point. The *flat round* or *olive-shaped*, is small, for the purpose of being insinuated into small round cavities, as those of cysts. A modification of the flat round, called reed-shaped (*cautère en roseau*, fig. 14), is occasionally used for the same purpose as the three-sided prism. The *button-shaped* or *nummular* is an inch in diameter, and a quarter of an inch long. The *three-sided prismatic* iron, much employed by Rust, is an inch and a quarter long, and each side three-quarters of an inch broad, the edges being trunated, and one of them directed upwards. The *halbert* or *hatchet-shaped*, is employed for the purpose of simple linear, or transcurrent cauterization. For minute surfaces, the stilet of a trochar, or a knitting or large sewing needle may be employed, and at need in place of the larger instruments, the surgeon may lay hold of any piece of iron or copper within his immediate reach. The iron is to be raised to the temperature desired, by the fire of a brazier or charcoal chafing dish, which should be blown by bellows, and brought to the surgeon at the time of operation, so that the iron may not cool by being carried through the air. The healthy parts near the site of the operation, should be protected with a pledget wetted with cold water; after the operation no other dressing will be required than a simple linen compress similarly soaked. If inflammatory symptoms arise it will be necessary to employ antiphlogistics; and to facilitate the detachment of the slough, it will be advantageous on the second or third day, to resort to the use of emollient poultices or the warm water dressing. In employing the caustic, it is necessary to have it raised to the white heat, as it destroys the tissues much more rapidly at this pitch of temperature, and with infinitely less pain, than at the gray or red heat. The iron, as soon as it begins to cool, which is shown by the alteration of colour, should be changed for another; the surgeon taking care under all circumstances that it shall not cool by resting on the eschar for fear the latter should become adherent to, and be detached with the iron, causing great pain, and risk of hemorrhage. As a general rule, the slough produced by the iron does not extend beyond the site of its application. The resulting inflammation and suppuration are usually of a healthy character, and their effect in rousing the

vitality of the neighbouring textures, and removing their tendency to degeneration, is far greater than that following the use of the caustic potash. In flaps, raised in plastic operations for the purpose of filling the breach left after the extirpation of cutaneous cancer, Dieffenbach does not hesitate to sear the under surface immediately before their adjustment, if he has reason to suspect that they share in the least degree the tendency to degenerate. In stercoraceous abscess by the side of the rectum, malignant pustule, gangrenous rupia, and other analogous affections, I have found it one of the most efficient and rapid means of cure. From the powerful afflux of blood it occasions to the spot on which it is applied, and the depth to which its influence is felt, it has been much employed, especially by the surgeons of the European continent, as a counter-irritant in scrofulous affections of the bones and joints, as it is believed to bring back in this manner, the red blood into the parts previously gorged only with serous fluids, so as to determine a deposit of fibrin susceptible of serving as the basis of healthy consolidation. It is also resorted to in poisonous wounds, paralysis and rheumatism, and especially, in consequence of the dry, firm, compact eschar it produces, for arresting hemorrhage, when other means fail or from particular circumstances are inadmissible. Larrey, it is alleged, has obtained remarkable success from it, in cases of phlebitis of the stump after amputation; and others, by applying it at points, have been equally fortunate, after the phlebitis was manifested in the veins of the limb, and under circumstances nearly hopeless. Through warts and in ranula, and in erectile tumours seated in parts that forbid the use of the knife, it has been directed to pass heated needles; but the practice, according to the author's experience, is, in all these affections, inferior to the means of treatment more commonly employed. In opening large chronic abscesses, in which the integument has become thin and livid, it has been advised by Larrey to use the heated trocar stilet.

There are three different modes or processes of applying the cautery:—

1. The *radiant* or *objective*.—In this the heated button-shaped iron is held at the distance of six inches in order to throw the radiant heat upon the part, and is gradually approximated to the surface as the iron cools. This mode is but little used. It reddens and swells the tissues, and was formerly employed in cases of erysipelas, atonic ulcers and scrofulous tumours. A live piece of anthracite coal might be used with the same advantage.

2. *Transcurrent cauterization*.—This consists in running one angle of the prismatic or the edge of the halbert-shaped cautery heated to a white heat, lightly over the surface of the skin, so as to make a number of parallel lines, or rays of fire as they are called, from two to six inches long and from one and a half to three inches apart, involving only the substance of the skin. It is sometimes resorted to in cases where it is desired to produce a powerful irritation of the skin with little loss of substance, as in cases of fungus articuli and hip-joint disease. The number and length of the rays are to be proportioned to the effect we wish to produce. The tracts should be traced previously with ink, over which the iron should be passed lightly, one, two or more times. The eschar which follows is of a golden colour, and seems at first a mere line, but when it comes away it will be found to have involved the whole substance of the skin. Cicatrization follows

promptly, and is attended with an obvious narrowing or diminution of the surface of the skin. Dry flannel or warm linen cloth should be at first applied about the limb to keep up the stimulation; and emollient poultices subsequently resorted to, when the eliminatory inflammation becomes developed.

3. *Inherent or proper cauterization.*—In this the action of the cautery is sustained for a time in contact with the tissues. It is the method in by far the most common use, as it is employed whenever we wish to destroy tissue deeply or over a broad surface. Any of the various forms of the cauteries may be used, though those of large size are usually to be preferred. It is necessary to have the surface before using the iron as dry as possible, for the moisture of the part almost immediately cools the iron, so as to diminish its cauterizing power while it increases the pain. If the parts are freshly incised, as in the operation for caries, it will be necessary to wait till the bleeding has in a great degree ceased, and to have several heated irons at hand so that they may be used in turn.

VI. REUNION BY SUTURE.

The union of divided parts is always directly accomplished by the organic or instinctive action of the vessels on the sides of the section. The aid which the surgeon affords consists merely in properly retaining them in permanent apposition, without unnecessary tension, and giving the parts involved such a position as shall more or less relax the surrounding muscles. Reunion may take place in two modes, which have received the names of *first* and *second* intention. In that by first intention, there is a direct adhesion of the divided parts without any previous formation of pus. In that by second intention, suppuration, attended by a growth of granulations, is the means of cure; the granulations, which form upon the sides and at the bottom of the opening, ultimately uniting together so as to become the medium of adhesion. There is a sort of union intermediate between the two, called *immediate secondary* union, which is occasionally resorted to with considerable advantage in practice. In this the sides of the wound are not closely approximated till after they are covered with lymph forming a layer of incipient granulations; they are then brought together, and union takes place with very little or no subsequent suppuration.

The *means* by which the parts are held in apposition, consist of sutures, adhesive straps, and bandages. Of the first, more than twenty different kinds were employed by the older surgeons; but since the adhesive plaster, which may be cut into any convenient shape for application, has been brought to its present degree of perfection, the following kinds are the only ones commonly employed in practice, viz: the *interrupted*, the *glover's*, the *quilled*, and the *hare-lip suture*. Other forms are still occasionally used in particular cases of injury, as in wounds of the intestine, and will be hereafter noticed.

RULES FOR THE APPLICATION OF SUTURES IN GENERAL.

1. To clean the lips of the wound of all foreign bodies and coagulated blood, without interfering with the thin coat of fibrin that in a few hours forms a glazing over the raw surface.

2. To enter the needle at an angle of about 45° , so as to get a sufficient hold in order to unite the lips by a broad edge, and at a distance from the margin, proportioned to the length of the wound, and its tendency to open.

3. Whether the needle enters from without inwards, or from within outwards, the points of perforation should be opposite, so as to close the parts without wrinkling, and make the thickness of the substance embraced as nearly equal as possible on both margins of the wound. It is usually proper to pass the needle merely through the skin and subcutaneous cellular tissue; but in cases of deep cuts involving the muscles, or in wounds following resection or amputation, they may sometimes be passed with advantage through a portion of the divided muscle.

4. If the wound involve a free margin like the lip, or detach an angular flap, the first suture should be applied upon the projecting angle in order to bring the parts into their proper relations with each other. In a long incision over a flat surface, it should for the same reason be applied near the middle of the wound.

5. The distance between the points of application should be nearly equal. The two terminal ones should, however, be one-half nearer the angles of the wound than to the adjoining sutures. If reliance is solely placed on the sutures for closing the wound, a sufficient number must be applied to make the line of union complete, without the intervention of gaping orifices. In general, however, it will be found better, excepting in cases of plastic operation, to employ a fewer number of sutures, and adjust the parts between them with adhesive straps. It will rarely be found necessary to employ more than three or four points of suture; and to insure an exact apposition of the edges of the wound, it is best not to begin to tie them till after all are applied.

6. The knots of the ligature should be made upon the side, not over the line of the wound, and as much as possible on the opposite margin to that over which the discharges may be expected to flow. They are to be tied only with a moderate degree of tightness,—just sufficient to bring the lips together, for if more firmly drawn they give rise to strangulation and ulceration of the substance inclosed. If the parts are thick, or are strongly disposed to separate from muscular action or other causes, so as to draw tight on the sutures, resort must in all cases be had to auxiliary means of support by adhesive straps, which act over a large surface, or of graduated compresses laid along the edges and retained by a suitable bandage. The limb must also be so placed as to relax the muscles concerned.

7. The use of sutures is to facilitate adhesion. They are, however, irritating of themselves, and should therefore be removed as soon as they cease to be absolutely necessary to keep the lips of the wound in contact. If too long retained they either convert the track through which they have passed into a seton, or cut out so as to leave deformity. The time necessary for reunion by the first intention varies from three to eight days, according to the state of the part and the character of its organization. On the eyelids, where the skin is thin, it is customary to remove the sutures in a much less period even than three days, in order to avoid the oedematous inflammation to which they are there apt to give rise, if too long retained *in situ*. In removing the sutures it is necessary in most cases to moisten and cleanse the thread before cutting the knots. If the adhesion should not appear strong, a part

of them only is to be removed at a time, and a strip of adhesive plaster applied in place of the suture that has been taken away. The material commonly employed in sutures is a waxed silk or hempen thread which may be used either single or double, twisted in the form of a cord or flattened like a ribbon. In some delicate plastic operations, a woolen thread may be used with advantage, as it seems less disposed to cut the parts.

INDIVIDUAL SUTURES. (PL. VI.)

1. *Of the interrupted suture*, (fig. 10, a.)—This is made with a curved semicircular needle, held, with the thumb placed in the curve and the index finger on its back. Whether it be passed from without inwards or in the opposite direction, the point should be entered perpendicularly and the needle brought round with a sweep. The loops are commonly at least an inch apart. If separate ligatures are used, they may be armed with the needle at one or both ends. In many cases it is more expeditious to follow the practice of Lafaye; to employ one long ligature armed with a single needle, and carry it successively through at the different points, dividing the thread afterwards so as to form separate ligatures. After the T or star incision a single suture through the

separate angles suffices to bring them together. An assistant in cases of large or deep wounds, should bring the edges together while the surgeon closes the knots.

2. *Glover's suture*, (fig. 10, c.)—This is but little used, except in post-mortem examinations, and in some wounds of the intestines. It is a continuous stitch passed obliquely from right to left, at equal intervals, across both edges of the wound. The loops are all tightened at once by drawing on the two ends of the thread. The tendency of this suture to strangle the parts which it embraces in its spiral turns, has caused its nearly total exclusion from practice.

3. *Quilled suture*, (fig. 11, e.)—This differs only from the interrupted suture, in having the separate threads passed double through the eye of the needle, so as to leave a loop at the exit of the needle on one side of the wound, and the ends at its place of entry on the other. When the loops are all placed, the barrel of a quill, or a piece of stick or bougie, is inserted within the loops on one side, and another between the tails of the ligatures on the other side of the wound. The tails are then to be drawn tight and knotted. This suture was in great favour with the older surgeons, and is probably too little used at the present day. It is of course only applicable in straight wounds. It serves admirably

PLATE VI.—SETON—MOXA—ACUPUNCTURE NEEDLES—SUTURES—CAUTERIES.

Figures 1, 2, 3, 4.—Application of a seton to the back of the neck.

Fig. 1.—A fold of skin, through the base of which a bistoury has been passed. The bistoury is shown just as it is about to be withdrawn so as to prolong the incision.

Fig. 2.—Mesh or seton tape, passed with the eyed probe—the fold of skin subsequently relaxed.

Fig. 3.—Boyer's seton needle, threaded with the mesh.

Fig. 4.—A convenient seton needle: less used, however, than the former.

Figures 5, 6, 7, 8.—Moxas, and instruments for applying them.

Fig. 5.—Common moxa in a state of combustion held upon the skin with a pair of forceps. The burning is accelerated by blowing on it through the pipe. Commonly, the mouth of a small pair of bellows are used instead of the pipe.

Fig. 6.—A small moxa, of the form preferred by M. Sarlandière.

Fig. 7.—Port-moxa of Larrey. A convenient instrument, but not absolutely necessary.

Fig. 8.—Blow-pipe of Larrey.

Fig. 9.—Three acupuncture needles, of the size commonly used in practice, having separately a round, an annular, and a movable head.

Figures 10, 11.—Sutures.

a. Interrupted suture.

b. Twisted or hare-lip suture.

c. Glover's or continuous suture.

d. Another form of continuous suture, but little used.

e. Quilled suture.

Figures 12 to 17.—Metallic cauteries. These are formed of steel or copper, and the stem to which they are attached set in a movable handle.

Fig. 12. Halbert or hatchet-shaped cautery. The thickness of the blade is shown in profile in the small figure adjoining. The handle, which is too long for the space in the plate, is broken, or a piece taken out, as it were, at a.

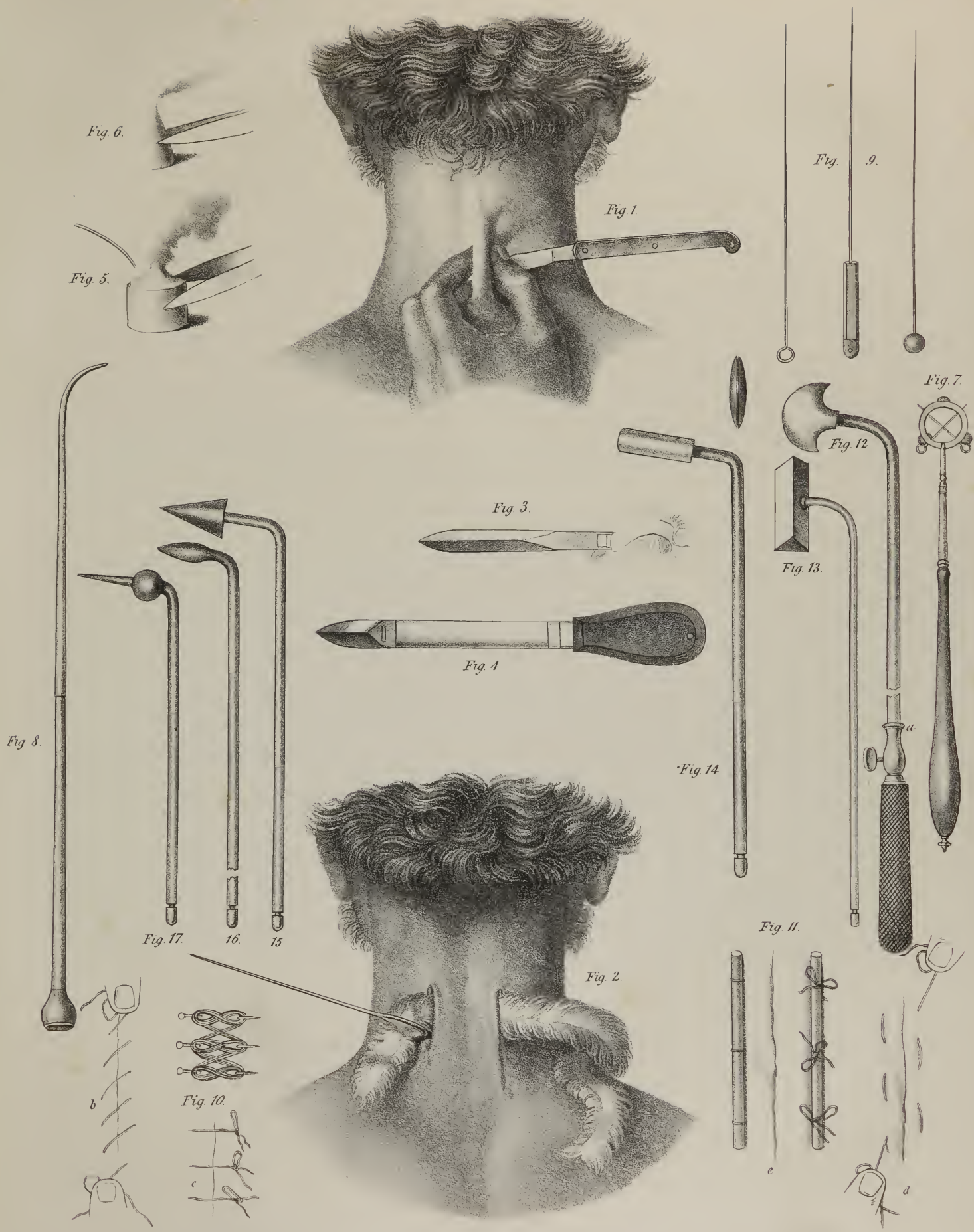
Fig. 13.—The three-sided prism of Rust.

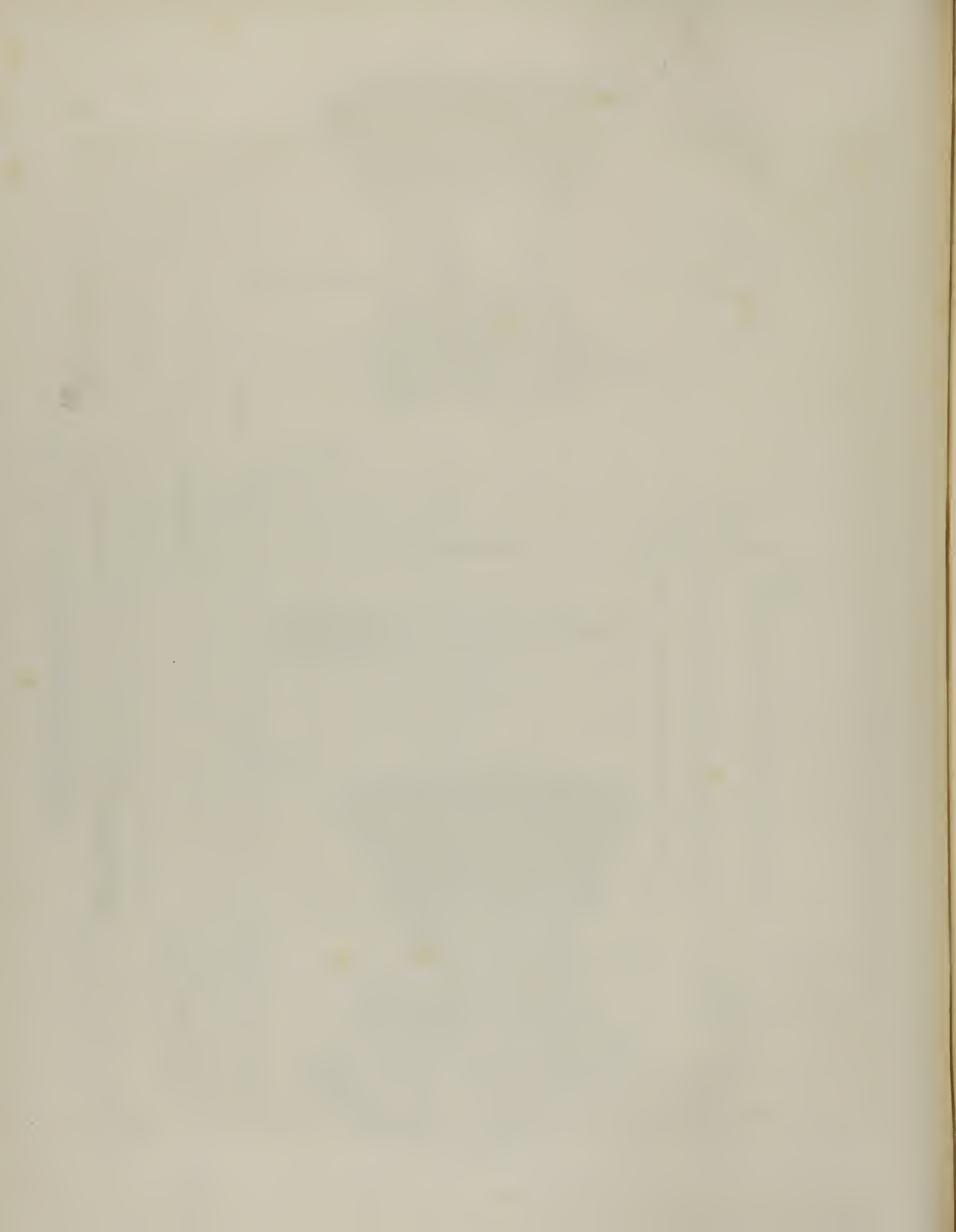
Fig. 14.—The reed-shaped cautery, (cautère en roseau,) formed like the mouth-piece of some musical instruments.

Fig. 15.—The conical cautery.

Fig. 16.—The olive-shaped or flat round.

Fig. 17.—A modification of the common cylindrical cautery, devised by M. Charrière, for the cauterization of poisoned wounds.





when the wound is deep to bring the lips extensively in contact, and admits of stronger traction on the threads, as these are prevented by their mode of application, from strangulating and cutting the parts.

4. *Twisted or hare-lip suture*, (fig. 10, b.)—This is made by means of straight needles or pins, which may be either cylindrical or lance-headed. As they are to be left in the parts, it is advisable to have them made of the unoxidable metals, silver, gold, platina or palladium. But the common sewing needles with a head of wax, the glass-headed pin of the toilet table, or the insect pin of the naturalist, answer very well under ordinary circumstances. If greased at the point they will be found to pass more readily through the tissues. This form of suture is the only one, the place of which cannot at need be supplied by adhesive straps and bandages. It is employed to fasten down angular flaps in cases where there is a section involving the whole substance of a part which is free on one of its margins, as the lip, the eyelid, or the ear; it is also used in a great variety of plastic and other operations. The lips of the wound being exactly brought together, the operator takes one of the needles between his thumb and fore finger, with its heel resting against the nail of the middle finger, and passes it through both sides of the wound, traversing the tissues from right to left. The point should be entered nearly perpendicularly upon the skin a line and a half to two lines from the margin of the wound; the pin is then to be inclined horizontally and brought out afterwards with the point looking upwards over the end of the left fore finger, which should be placed so as to make pressure against it; circumscribing in the case of the lip at least two-thirds of its thickness between the skin and mucous membrane. The first pin should be passed near the free border; over the heel of this, a loop of ligature is to be thrown by the assistant and crossed under the point, so as to keep the surfaces from separating and in a state of tension. All the pins required are to be passed in a similar manner. The ligature is then to be wound separately round each of the needles in the form of a figure 8, or in a simple ellipsis, according to the will of the surgeon; or a single long ligature, in case of hare-lip, may be employed for the whole, commencing with the upper needle and then passing down to the second or third, finishing the wrapping of each in turn. To prevent the points from irritating the skin, or catching so as to be dragged by accident, they should be snapped off with the cutting pliers; or if the cambric needle be used, snapped between a couple of pairs of forceps. A pledget of linen or a strip of adhesive plaster may in addition be laid between the surfaces of the skin and the free ends of the needles. No other dressing is ordinarily required.

VII. OF THE SETON.

The seton is employed in nearly the same places and under the same circumstances as the caustic issue. It is not now used so much as in former times. It consists of a suppurating wound with two openings through the skin an inch or more apart, transmitting a skein of silk, a piece of tape or gum elastic, or a strip of linen (mesh) with some of the threads removed upon its sides, through the subcutaneous cellular tissue. There are two methods of forming the seton.

1st. *As made with the seton needle*. (Pl. 6, fig. 3, 4.)—A fold of skin is to be pinched up with the thumb and fingers, through the base of which the needle, threaded with the material to be introduced and previously covered with cerate, is to be passed. This is the most expeditious method and the one usually practised.

2d. *With the bistoury and eyed probe*. (Pl. 6, fig. 1, 2.)—A fold of skin is to be raised as above described, the upper part of which is to be held by an assistant. The bistoury is pushed through the base of the fold up to the heel, and as it is withdrawn, made to enlarge the orifice to the requisite dimensions. The common eyed probe of the pocket case, threaded like the seton needle, is carried through the track of the wound before the fold of skin is relaxed. The wound is to be simply dressed; on the back of the compress covering it, the tape or thread is to be folded up and secured with a bandage. By the third or fourth day suppuration is established, and the dressing should be removed. The tape is then to be oiled and drawn farther through the wound, and the soiled portion cut away. This process is subsequently to be repeated daily. If a strip of gum elastic or of sheet lead be used, simple washing will suffice to cleanse it, and the necessity of using a long portion, or of cutting away a part from time to time, is obviated. But to the tape or mesh, as more manageable, the author gives the preference. As the tract of the seton becomes indolent, it will be found requisite to smear the tape or mesh occasionally with some stimulating ointment in order to keep up the discharge.

VIII. OF THE FORMATION OF AN ISSUE OR FONTANEL.

For the purpose of effecting protracted counter-irritation attended by a discharge of pus, issues were frequently established in former times, and are still occasionally resorted to in chronic affections, especially for those of the bones and joints. They are small ulcers below the surface, kept artificially open by the introduction of some foreign bodies, as two or three garden peas, two or three pepper corns, the dried buds of the orange-flower, or a flat piece of wood with a rough surface, all of which require to be changed daily. They may be made in almost any part of the body, where the skin is not closely connected to a bone, a tendon, or a resisting fascia. The places of election, however, are the back of the neck, the inner side of the insertion of the deltoid, the inner side of the thigh just above the knee joint, the depression between the vastus internus and the sartorius, and the internal surface of the legs between the belly of the gastrocnemius internus and the insertion of the sartorius. They are made either by incision or cauterization.

By incision.—A fold of skin, of an extent proportioned to the size of the issue desired, is to be raised and divided through by a bistoury passed in at its base, so as to expose the subcutaneous cellular tissue. The lips of the wound are to be separated by a firm roll of lint or charpie, and this secured by a compress and roller. At the end of three or four days suppuration is established. The plug is then to be removed, and the dried peas or other foreign substances introduced and held applied by a square piece of adhesive plaster, or if necessary, by a compress and bandage. This method is expeditious and little painful. But there is no loss of sub-

stance in the skin; and from the strong tendency to cicatrization, it is difficult to keep the ulcer open. The formation of the issue by caustic potash, as described at page 23, is, therefore, the plan more usually followed.

IX. MOXA.

Any inflammable substance burnt upon the skin for the purpose of effecting its gradual disorganization to more or less extent, is called a *moxa*. The pain and irritation attending this process increase progressively during the combustion, are felt at greater depth in the neighbouring tissues, and are believed to effect a more powerful derivation where deep-seated parts, as the bones or joints, are affected, than any other mode of counter-irritation, except the actual cautery or heated iron. If carried so far as to completely destroy the skin, the ulcer which follows the separation of the eschar resembles that from the use of caustic potash, and is to be restricted in like manner to certain parts of the body. But when *tempered*, or limited to the production of an acute glow upon the skin, it is more generally applicable. A variety of substances have been employed. Those commonly used are formed of cotton wadding, prepared spunk, cotton, lint or tow, rolled into the form of cylinders, soaked in a solution of chlorate or nitrate of potash and thoroughly dried. The chlorate is preferred to the nitrate as the latter deliquesces as it burns. The cylinders should be from half an inch to an inch in diameter, and tightly sowed in a linen or silken covering, which should be coated with a thick solution of gum Arabic, so as to give them solidity. The cylinders are cut in sections of half an inch to three-quarters long, according to the degree of impression we wish to produce: each of these forms what is called a *moxa*. (Pl. 6, fig. 5, 6.) They are to be moistened with saliva at one extremity and applied upon the skin, lighted at the other. They may be applied through a common pill box, open at both ends, or held with a pair of common dressing forceps, or with the *porte-moxa* of Larrey. The surrounding skin should be protected by a piece of wet cloth, with a hole in the centre for the moxa. If not soaked previously in one of the solutions above mentioned, the combustion will require to be accelerated by blowing upon it with a common blow pipe, or with a pair of small bellows. As the combustion reaches the skin, it becomes exquisitely painful. The skin first reddens, shrivels, becomes then dry and yellow, and is covered with serous vesicles, which explode at the conclusion of the operation with a slight noise. The moxa is what is called *tempered*, when a piece of wetted paper or cloth is interposed between it and the skin.

X. ACUPUNCTURATION.

This operation consists in the introduction of fine, well-tempered sharp-pointed needles, through the integuments and into the subjacent tissues at variable depths. The fine point of the instrument is said to separate, not divide the tissues through which it passes; it is at least well ascertained, that the puncture is not followed by any serious consequences, and but very slightly painful. Through the muscles, vessels, and even many of the nerves and viscera, the needles have been passed with impunity.

It is a practice borrowed from the Chinese and Japanese. No great value is now attached to it as a remedial measure, in this country or in Europe, though its use has occasionally been attended with advantage in neuralgia, chronic rheumatism, indolent tumours, indurated lymphatic glands, etc. It is employed in two ways; the first consists in the simple use of the needles; the second in the application of two needles connected by an electric current, (*electro-puncture*.)

Simple acupuncture.—This is made from needles from one to four or five inches long, with round or annular heads, (Pl. 6, fig. 9,) to prevent them from slipping below the skin. A handle that can be removed or fastened to the heads at pleasure, facilitates their introduction. In the east, they are made of fine gold or silver; but steel, finely tempered so as not to be broken by the action of the muscles, is the material invariably preferred in this country. The needle may be introduced, as is the custom with the Japanese, by driving it forward with a small mallet; or by the following method, which is decidedly preferable. Having selected the point—which should be the seat of the pain or in its immediate vicinity—the operator stretches the skin with the fore and middle fingers of the left hand, pierces it perpendicularly with a gentle pressure, and then advances the needle to the desired depth, with a semi-rotatory motion of the head between the thumb and fore finger of the right hand. This process is to be repeated till the requisite number of needles are introduced. Their withdrawal, after they have been left in a sufficient length of time, is to be effected by the same movements, accompanied with slight traction. A drop or two of blood is occasionally seen oozing afterwards from the place of puncture. Care should be taken to have the needles, before using them, perfectly smooth and free from rust, as otherwise the introduction is more difficult and painful. For this purpose it is well, according to the advice of Dr. Elliotson, to pass them through an emery bag, both before and after using them.

The number of needles employed is varied according to the will of the operator, from one or two to twenty, and there is no general rule in regard to the length of time that they ought to remain applied. The Japanese and Chinese keep them in only while the patient makes thirty inspirations. M. Cloquet and Dr. Elliotson state that they derived most advantage from the method when the needles were kept in for several days; and Professor Bache, who has extensively employed them in chronic rheumatism, observes that the more chronic and long-standing the disease, the greater will be the length of time that they should be retained in the tissues.

Simple acupuncture has been made through the coats of the arteries, for the purpose of obliterating their cavities; the needle being allowed to remain three or four days, so as to excite inflammation and serve as a mechanical obstacle, upon which the blood may coagulate. The practice, however, is one not to be relied on.

Acupuncture has also been employed with some success by Mr. Lewis and others, for the cure of hydrocele, for the removal of the fluid in anasarca, for œdema of the scrotum, penis, and eyelids, and in exploring the nature of some deep-seated tumours or abscesses.

Electro or galvano-puncture.—The needles for this purpose should have a small ring at the top. (Pl. 6, fig. 9.) Two of these

should be inserted at the limits of the region through which the electric current is to be passed, and the conducting wires of the two poles of a galvanic pile attached to the rings at their top. A horizontal galvanic pile of small dimensions, is much easier managed for this purpose than the vertical pile of Volta or the Leyden jar. A few pins only should be used at first, and the number gradually augmented as the patient is found able to endure the action of the current.

XI. MEANS OF PREVENTING HEMORRHAGE; OR, SURGICAL HEMOSTATICS.

I. ON THE MEANS OF PREVENTING HEMORRHAGE, AS APPLIED PREVIOUS TO OPERATIONS.

These measures are directed solely upon the large trunks of the arteries, and consist of two kinds, *compression* or *previous ligature*. The latter, however, is rarely resorted to with this object, and forms of itself an operation apart, which will be treated of under the head of ligature of the vessels.

Compression for the purpose of arresting the flow of blood through an artery, must be applied with sufficient force to flatten the vessel, and cause the temporary obliteration of its cavity. It is to be carefully kept up during the whole course of the operation. The vessel should be compressed at some part of its course, where it may be felt with pressure of the finger, and where it is at the same time placed over a bone or some firm fibrous structure that may serve as a point of resistance. It is to be made by the direct application of the hand, or by the medium of instruments.

OF THE MODE OF COMPRESSION IN GENERAL.

WITH THE HAND.

1. *With the thumb and fingers*.—It may be made with the point of the thumb alone, pressed downwards; with the balls of the two thumbs applied one above the other across the course of the artery; or with the ends of the fingers of one or both hands placed parallel with the track of the vessel. Either one of these modes is rendered peculiarly applicable in certain situations by the anatomical position of the vessel. Thus the subclavian, deeply situated as it crosses the first rib, and accessible only through a narrow space, can be reached best with the end of the thumb, with which it may be compressed with considerable precision. The circulation of the femoral artery may also be controlled by pressure with the end of the thumb immediately over the pubic bone; but immediately below the pubis it is better accomplished with the balls of the two thumbs, either hand taking a firm point of support by grasping the opposite surfaces of the thigh. On the other hand, the great arteries of the arm and thigh, which are placed at some distance from the bone, and disposed to roll under compression by the two first processes, may be obliterated more securely with the ends of the fingers of one hand placed in the direction of their length, while the palm grasps the mass of neighbouring muscles, and the thumb gets a resisting hold upon the surface of the bone, or by sinking itself into the flesh (Pl. 7, fig. 3). From the difference in their length, the fingers, when they

act with force sufficient, as in the thigh, for instance, to overcome the resistance of the tissues, close on the artery in a curved line, so that the obliteration of the vessel is begun by the first finger, continued by the second, and completed by the third. If the fingers become fatigued during the continuance of the operation, the individual making the compression, should, without waiting till the hand begins to tremble so as to render the pressure uncertain, sustain it with the fingers of the other. One hand may even be readily substituted for the other, without interrupting the compression, by placing the ends of the fingers of the second hand along the track of the vessel, just above those of the hand first applied, so that the new pressure is made before the first is relaxed; the second hand sliding gradually into the place of the first. In the same way one assistant may be substituted for another, in case the lumbar muscles of the first become greatly fatigued in the constrained position which he is obliged to assume. In making the compression, no more force should be used than is just sufficient to completely efface the calibre of the artery; the requisite amount may be ascertained, according to the directions of Lisfranc, by placing a finger upon one of the larger branches of the main trunk. The pulsation in this will be found gradually to disappear, as the pressure with the fingers is augmented above, and as soon as it ceases to be felt, the temporary obliteration of the vessel may be considered perfect. Considerable coolness and intelligence are required on the part of the assistant in this simple manœuvre with the hand, and it is far better, especially if the operation is likely to be protracted, to resort to the tourniquet, which answers perfectly well in all cases in which the operation is not done so high on the limb as to forbid its application.

2. The *whole hand* is sometimes employed in cases of emergency, for the compression of the abdominal aorta and iliac vessels.

3. *With the hand pad*. (Pl. 7, fig. 5).—The hand pad is pressed downward upon the artery, so as to act precisely like the end of the thumb, to which, as not endowed with sensation, it is very inferior. It is, therefore, rarely employed. It has been recommended in cases where the subclavian artery is unusually deep, and the separation between the scaleni very narrow. It is seldom, however, even under these circumstances, that the compression cannot be better and more safely accomplished with the thumb or the end of the middle finger. The shape of the hand pad is to be varied according to the form of the part through which it has to act. It should be long and narrow for the subclavian, large and broad for the aorta, and attached to a short handle to render it more manageable, like that of the letter seal, a door key, or a boot hook, which, when padded at the end, are occasionally substituted for it.

MECHANICAL COMPRESSION.

The instruments with which mechanical compression of the vessels is made, consist of the garot, the pad with a strap and buckle, the tourniquet, and the compressor of Dupuytren.

4. *The garot*. (Pl. 7, fig. 9).—This was devised by Morel in 1674, as a substitute for the circular bandages or ligatures employed previous to that period, for the purpose of arresting hemorrhage. As first used it consisted merely of a band or handker-

chief twisted tight with a stick. This simple contrivance, from the convenience of its application on the field of battle, received the name of the *field tourniquet*. The garot, as it has been latterly modified, consists of a pad to be placed on the skin above the artery, presenting on its free surface a ring for the passage of the web or strap. On the side opposite the pad is applied a compress, or what is better, a concave piece of horn or metal, upon which the strap is to be firmly twisted with a stick, and the latter given in charge of an assistant, who is to diminish or increase the pressure according to the direction of the surgeon. The compression of the garot extends to the whole substance of the limb—arteries, veins, and nerves—and cannot, therefore, be safely

kept up but for a short space of time. The advantage which it offers, of being constructed of the first things at hand, and at any time or place, renders it occasionally highly useful. It cannot, however, be gradually relaxed and tightened with precision like the proper tourniquet, which is always to be preferred.

5. *Detached pad, (pad of Charrière,) with buckle teeth on its lateral margins, to which the two ends of the strap are attached.* (Pl. 7, fig. 5.)—This has but recently been introduced into practice, and is employed for the compression of superficial arteries of medium size. The pad is attached to a plate, and resembles somewhat the lower frame of the French tourniquet, (fig. 4,) and is forced down over the artery, by fastening the two ends of the

PLATE VII.—COMPRESSION OF THE ARTERIES.

OF THE TEMPORAL AND SUBCLAVIAN.

Fig. 1. (A). Compression of the temporal artery, with the pad of M. Charrière, (see fig. 5.) The pad is applied in front of the ear, above the zygomatic arch, and is sustained by a simple strap, the ends of which are fastened upon the two rows of buckle teeth. The double compress under the jaw protects the skin from injury.

(B). *Compression of the subclavian with the newly devised instrument of Bourguery.* This is composed of four principal parts.

1st. A broad rectangular pad (A) screwed to a steel plate, which, though not visible in the drawing, is fastened to a second plate (B). This pad is applied across the attachment of the pectoralis major below the clavicle, which serves as a point of support to it. One end of the pad is thick, so as to fill up the depression below the coracoid process, while the other is thinner and rests on the sterno-clavicular articulation. By reversing the margins, the same pad may be applied for compression of the artery of the other side.

2d. A second plate of steel (B), of the same form as the preceding, upon which it is exactly fitted. They are fastened together by two small pivot keys (*b*), which enter into corresponding mortises in the plate (A). This second plate serves as a fixed point for the rest of the apparatus. At its ends are two copper pins for the attachment of the straps.

3d. A movable steel plate (C) fastened by a screw to the second plate, capable of being turned for a quarter of a circle to the right or left, so as to suit the obliquity of either clavicle. It serves as a fixed point for the lever of the movable pad (G), with which the compression is made. Above it is attached by a hinge joint (*d*) on each side, with another plate of an elliptical or horse-shoe shape (D), which is thus made mobile so as to adapt itself to the projection of the trapezius. This elliptical plate is padded and provided with two pins (*e*), for the attachment of the posterior straps. The hollow within it is occupied by the artery pad (G).

4th. The last part of the apparatus is the elbowed lever (E), which supports the artery pad. The base of the upright part of the lever is pierced with an opening, and is fastened by a screw (*f*) to plate (C); at its upper part it is attached by a bullet joint (*g*) to the horizontal arm (F) of the lever, so as to allow the latter to be moved in every direction. The artery pad (G) is in the form of an elongated cone, to penetrate readily between the scaleni muscles, and may be inclined in different directions in consequence of its mode of attachment to the horizontal lever.

The instrument when applied, is held securely in its position by the body bandage (H), and the anterior and posterior straps (I and K). By forcing it down with the screw (*i*) the artery pad may in all cases, according to the inventor, be made to act so as to arrest safely the circulation in the vessel.

OF THE CAROTID AND BRACHIAL.

Fig. 2.—The instrument is represented as applied, on a plan of a section of the neck; and is so well shown as not to require any specific description. It is, with the exception of the form of the pad and bullet joint, similar to the compressor of Dupuytren.

Fig. 3.—*Compression of the brachial artery with the fingers below the axilla.* The fingers are seen sunk in the groove over the vessel between the triceps behind and the biceps and coraco-brachialis muscles in front. The thumb takes a support upon the opposite side of the limb.

Fig. 8.—*Compression of the same artery just above the middle of the arm, is here shown as made by the common English tourniquet; the instrument to which preference is usually given in this country.* A thick compress or

strap after they have passed round the limb, upon the rows of buckle teeth, with which its raised lateral margins are provided. The general compression of the limb may be obviated at will, by placing a thick compress under the pad, and another on the side of the limb opposite. I have in some instances employed this method with advantage; but as a general means, the pressure cannot be made sufficiently firm or certain to be relied on.

6. *The common tourniquet.* (Pl. 7, fig. 6.)—This most useful instrument was invented by Petit, and is so well known as not to need particular description. Several modifications have been made in the form of the instrument, as will be seen by reference to Pl. 7, but the rules for its application are much the same in all. When the instrument is applied, the frames should be put in contact, before the strap is buckled round the limb, as the tightening of the strap, in order to compress the vessel, is made by turning this screw, so as to separate the upper plate from the lower. The form of the tourniquet in common use in this country and Great Britain, is represented at Pl. 7, fig. 6, and fig. 8. In ap-

plying this instrument it is not a matter of much moment, whether the operator places the frames, or the free pad attached to the strap directly over the vessel. In either case, a stout compress or roller is to be laid immediately on the surface above the artery. In general, however, it will be found preferable to buckle the pad over the vessel, and keep the frames on the upper surface of the limb, so as to prevent their position becoming deranged by their weight.

In some of the recent modifications of the French instrument, the lower plate of the tourniquet is forced *downward* by the screw, and should, therefore, be placed immediately above the vessel. The tourniquet, though far more manageable, presents some of the disadvantages of the garot, in producing a general constriction of the limb, so as to dam up some blood in the veins, which is necessarily lost during amputation; and produces, if too long continued, engorgement and even gangrene of the parts below. It is, however, well suited to effect the temporary compression required in amputation and other processes involving the large ves-

roller is observed lying over the artery, upon which it has been pressed down by the tightening of the strap, caused by the separation of the plates in turning the screw.

Fig. 9.—*Compression with the garot* or field tourniquet is seen in fig. 9. A small compress rolled tight (*a*), is applied over the vessel (*b*). A transverse bandage is applied to hold the compress, and twisted tight with the stick (*e*). The stick is secured with a cord, as at (*d*), to prevent its turning; (*e*) is a plate of wood, horn, a piece of card, or some similar substance, introduced below, before the tightening of the bandage, to protect the skin.

OF THE FEMORAL ARTERY.

Fig. 4.—The thigh is semiflexed on a pillow, and the artery compressed both at its upper and middle part.

Compression at the pubis, with the modified tourniquet of Petit. This instrument is preferred to all others by the French surgeons. Unlike the English instrument, it has an artery pad (*a*), sewed upon the lower plate (*b*). This is moved by a screw (*c*), and kept straight in its descent upon the artery by two conducting rods (*d d*), which pass through another smaller metallic plate (*e*), that supports the compressing strap (*g g*). On the opposite side of the limb is a counter pad, supported on a plate not seen in the drawing. The strap envelops the whole apparatus, by passing longitudinally over the upper plate and over that of the opposing pad. The strap is split where it passes over the first, to transmit the screw and the two conducting rods, and its two ends are fastened by a buckle (*i*) upon the side of the limb. At (*h*), a sort of staple is seen by which the pad is kept from slipping off the upper plate.

The instrument is here seen applied. The pad (*a*) rests upon the artery over the pubis. The straps pass under the folds of the buttocks, and compresses are placed below them to protect the skin. As the pad, at its application upon this part of the limb, has a tendency to rock over upon the thigh, it is secured by a long compress (*B*), which is attached to a body bandage (*b*). Compression is made by turning the screw, so as to force the pad towards the vessel.

Fig. 7.—*Compression upon the middle of the thigh with the compressor of Dupuytren.* This instrument is composed of two elliptical metallic bars, which slide over each other so as to lengthen or shorten it. Near each end there is a strong hinge joint. Its anterior end sustains the screw (*G*), the two conducting rods (*H*), and the movable artery pad (*I*) with which the artery is compressed. Its posterior part is constructed precisely as the posterior portion of the instrument shown at fig. 2. The counter pad (*F*) supported on the arm (*E*) is applied over the muscles at the back part of the thigh. The manner in which the two sliding bars are joined together and rendered fixed by a screw, is shown at (*D D*, fig. 2).

Fig. 5. *The artery pad of Charrière.* The pad is attached to a metallic plate, upon the upper part of which is placed a small saddle of the same material. Between the two branches at either end of this saddle are the rows of buckle teeth, and a sliding roller over which the strap plays. One end of the strap is secured in the drawing to a row of these teeth, the other, having formed a loop as in embracing the limb, is passed over the roller, and is ready to be drawn tight and secured on the second range of teeth.

Fig. 6. *The ordinary English tourniquet.* The two plates have been separated by turning the screw, in order to show the manner in which the strap is connected with them.

sels, when the operation is done sufficiently far from the trunk to leave room for its application.

The French instrument is shown applied at Pl. 7, fig. 4, on the upper part of the thigh; the English at Pl. 7, fig. 8, and at Pl. 43, fig. 6, where it is made to compress the artery of the thigh in a position that will be found to answer in amputations of the leg.

When we desire to daily check for some hours the circulation of the vessel above an aneurismal tumour, for the purpose of effecting the coagulation of the blood and the gradual obliteration of the sac—a process to be preferred to the ligature of the vessels when an aneurismal diathesis is known to exist—the following instrument is entitled to a decided preference over the tourniquet, as it makes positive pressure upon the limb only at two opposite points. The same instrument, though capable of serving in cases of amputation, possesses in that respect no particular advantage over the tourniquet, and is more liable to displacement.

7. *Compressor of Dupuytren.* (Pl. 7, fig. 7.)—This instrument consists of two steel plates, from one to two fingers broad, which are curved on their flat and joined at their middle, so as to slide over each other, in order to allow it to be lengthened or shortened at will. To the ends of these plates two others are attached by a joint which supports the pads, the one movable, the other fixed, the whole instrument being curved so as to form when complete the two-thirds of a circle. When the compressor is applied, the pads rest upon the opposite sides of the limb; the movable one is placed over the artery, and is made to descend by turning a screw, so as to compress the vessel. The construction and mode of applying this instrument will be best understood by reference to the plate.

COMPRESSION OF THE INDIVIDUAL ARTERIES.

Of those of the face and cranium.—The compression of these is seldom required except as a means of arresting traumatic hemorrhage. When there is no urgent reason to the contrary, it is better to resort to this measure merely for the purpose of temporarily checking the hemorrhage while the bleeding orifice can be properly secured by a ligature.

1. *Of the temporal artery.*—This is easily compressed against the cranial bones, in any part of its course above the zygomatic arch. For the main trunk, the detached pad to which the two ends of the strap are buckled, described at page 30, and shown in its application just in front of the ear at Pl. 7, fig. 1, is the most appropriate. A graduated compress secured with the nodose or knotted bandage, suits very well to arrest the hemorrhage from one of its branches, and may be made to serve in the absence of a more fitting apparatus for compression of the main trunk. 2. The *frontal* and *infra-orbital* arteries may be compressed by similar means, where they come out from the orifices in the bones to take a position under the skin. The graduated compress for the infra-orbital should be placed nearly vertically, in the direction of a line from the external canthus of the eye to the ala of the nose of the same side—and for the frontal laid just above the superciliary notch. 3. The *facial* artery may be compressed just below the jaw and in front of the masseter with the finger, or by a graduated compress, secured in one of the modes just mentioned. 4. In injuries of the *occipital* or *posterior auricular* arteries, it is

best to apply two graduated compresses, one above and one below the lips of the wound.

Arteries of the neck.—In consequence of the mobility and great sensitiveness of the parts in front of the neck, the carotid is the only vessel of this region which it is possible to subject to compression. The ligature of this vessel would, however, except in cases where its temporary occlusion only was required, be a preferable, as it would be a more certain, and even in the end, a less distressing or painful proceeding. The compression may be made with the fingers, or with the proper compressor devised by Bourgery and Malapert, and shown in its application at fig. 2. The freedom of the anastomosis between the branches of the two carotids is so great as to render either the ligature or compression of the trunk of a single side of but little avail in erectile and other vascular tumours of the neck and head. When compression is resorted to, it has been *advised* to make it upon both trunks at the same time. For this purpose an instrument has been contrived with two pads, each of which is to be depressed with a screw between the edge of the sterno-cleido-mastoid, and the lower border of the larynx. The compression should, however, be made gradually, giving time for the vertebral arteries to dilate, in order to avoid the danger that might arise from suddenly interrupting the columns of blood sent to the brain by the two great carotid trunks.

Arteries of the arm.—The *subclavian* artery, as has been before observed during an operation involving the great branches round the shoulder joint, may be temporarily compressed by the thumb and finger inserted endwise between the scaleni muscles, as directed by Camper. For the permanent compression of the artery, in the cure of axillary aneurism, various forms of the tourniquet have been devised. No instrument, however, appears so well calculated to accomplish its object as the one lately devised by M. Bourgery, and shown in position, Pl. 7, fig. 1. The *axillary* artery is only susceptible of compression, at its passage over the second and third ribs. But at this place, from the thickness of the two pectoral muscles which cross in front of the vessel, it is impossible to command the circulation completely except in very thin subjects. The compression may be made with the ends of the fingers, as shown at Pl. 7, with the knuckle or with the hand pad. To facilitate the compression, the pectoral muscles should be relaxed by bringing them to the side of the chest, placing the shoulder in the state of adduction. The compressor invented by Dalh for this artery, is not to be relied on.

The *humeral* artery may be readily compressed at its upper part, just below the tendon of the pectoralis major, and between the biceps and coraco-brachialis, either with the fingers or one of the several instruments above mentioned; though from the contiguity of the nerves, that with the fingers is found least painful. In any other part of its course no difficulty attends the compression; the thumb or the fingers usually sufficing as well as any of the more complicated instruments. When at liberty to choose, the junction of the inferior with the middle third of the arm, is the most favourable site, as the median nerve is here found running inwards so as to separate itself from the artery. The *radial* and *ulnar* arteries may be compressed against the corresponding bone, in any part of the inferior third of the arm, temporarily with the fingers, or permanently with the free pad and strap (described page 30;) or, if

at hand, the more complicated *compressors of Dupuytren*, of a suitable size, may be used.

Arteries of the lower extremity.—The femoral artery may be temporarily obstructed, at the upper or lower surface of the os pubis, with the end of a single thumb, or the flat surfaces of both, as observed at page 29. The tourniquet may also be applied in the same location, provided it be placed as represented in plate 7, fig. 4, with the strap passed under the fold of the buttocks, and the skin protected with double compresses behind and upon the sides, so as to admit of the strap being tightly drawn, and the frames of the tourniquet raised up upon the pubis, by a compress fastened to a body bandage. In the *upper or middle third* of the thigh, or in the *popliteal* region, compression is easily effected with the ordinary tourniquet or the compressor of Dupuytren. Compression of the artery at the latter point rather than in its course along the thigh is preferred by Professor Ferguson in amputation of the leg, as being attended by a smaller loss of venous blood, in consequence of the less capacity of the veins below the place of constriction.

The *posterior tibial artery* is accessible to pressure at two points: at the inferior extremity of the leg, between the tendo-achilles and the flexor tendons above the ankle; and between the internal ankle bone and the heel, in its course along the sinuosity of the os calcis.

The *anterior tibial artery* may be readily compressed over the middle of the front surface of the ankle joint where it can be felt pulsating. The graduated compress secured with the pad and buckled strap answers well for this object.

Arteries of the trunk.—The *external iliac artery* may be compressed for a brief space of time with the hand pad or the back of the fist, against the upper margin of the pelvis, provided the abdominal muscles be placed in a state of relaxation. Little advantage, however, is likely to be derived from this measure, except to gain time by the temporary control of the circulation for the application of a ligature, in cases of accidental injury of the artery or its branches, near Poupart's ligament.

The *aorta*, as has been before observed, may be compressed in the lumbar region, provided the muscles of the abdomen be thoroughly relaxed, by a mutual flexion of the trunk and pelvis. The back of the hand placed crosswise, and pressed down with moderate force, or a large hand pad, may suffice for the purpose. The application of the latter is occasionally made in the operation for ligature of the iliac arteries, though in the hands of a skilful surgeon it may very safely be dispensed with. When employed for the purpose of arresting uterine hemorrhage after accouchement, six or eight minutes compression, according to Trehan, Baudelocque, and others, has been sufficient to permit the uterus to assume its contracted state, and thus present the natural obstacle to the recurrence of the hemorrhage. The hand pad should be applied across the linea alba two inches above the umbilicus, and with its lower edge a little inclined downward.

II. MEANS OF ARRESTING HEMORRHAGE DURING OPERATIONS.

Measures for this purpose are rendered necessary, when from the situation of the part, as in operations upon the root of the neck, shoulder, or hip joint, it is difficult to compress the principal

trunks; or in other cases where the means of compression are liable to become temporarily displaced. The bleeding may take place either from the arteries or veins. As the peculiar application of these measures will be noted in reference to each important operation, it is not necessary to do more in this place than briefly enumerate them.

Arterial hemorrhage.—There are three different processes, by which this may be arrested during the operation.

The *1st process* consists in a direct compression of each bleeding orifice with the end of a finger. This is done usually by one or more assistants, and may, according to circumstances, be maintained to the end of the operation,—until the compression has been re-established on the main trunk if it had previously become displaced,—or until a ligature may be got ready to tie the opened vessel.

The *2d process* is a mediate or indirect compression of the divided vessels, and is principally used in flap amputations about the joints, where the fingers of an assistant can follow the knife so as to grasp between them and the thumb the vessels in the whole thickness of the flap. It is employed also in operations upon free margins, like the lip, nose, and ear, which are held by both surfaces in a similar manner. The *3d process* consists in a previous ligature of the main trunk, as in Larrey's method for amputation at the hip joint.

Venous hemorrhage.—This arises from two causes: 1st, from the compression of the limb necessary to flatten the artery, which prevents the ascent of the blood through the veins. In this case the bleeding ceases of itself, as soon as the compressing force is removed. 2. From some impediment to the circulation of the blood through the lungs, dependent upon the cries and efforts of the patient—met with commonly only in operations near the root of the neck, or the top of the chest. When it arises from this cause it suffices usually, in order to arrest the hemorrhage, to cause the patient to make several long inspirations in quick succession. It is important, however, in operations on the root of the neck, to make pressure when it is possible upon the vein before it is cut, especially if found in the midst of hardened tissues, in order to prevent the passing of air into the course of the circulation.

If the bleeding should not cease, pressure may be made on the orifices for some minutes with the finger; this, by causing a coagulation of the blood, may arrest the flow. As a last resort, each vein may be tied as an artery, though this measure is always attended with more or less risk of phlebitis. The same plans are to be pursued for the purpose of arresting the bleeding from the veins after operations.

III. MEANS OF ARRESTING ARTERIAL HEMORRHAGE AFTER OPERATIONS.

Direct ligature of the open mouths of the divided vessels, aided by compression of the cutaneous surfaces with adhesive straps, compresses and bandages, are the means ordinarily relied on for this purpose. Various other ingenious measures have been devised, some of which may occasionally be practised with advantage. These will be noticed in succession.

By ligature.—This process is applicable to arteries of all sizes, from those of the largest calibre, to such as emit only a feeble jet

of blood. Its first effect is to close immediately the opening of the divided vessel, put an instant stop to the bleeding, and cause a stagnation of the blood between the place at which it is applied, and the first collateral branch of importance given off by the vessel above. Subsequently the coagulum becomes absorbed, and its place is supplied by the effusion of lymph from the sides of the lining membrane, which gradually obliterates the cavity and converts the end of the vessel into a cord; the ligature is finally loosened by the division of the part within its grasp, and causes an effusion of lymph on the *outer side* of the vessel, which attaches it firmly to the surrounding parts.

Material employed.—A single silk or hempen thread sufficiently large and strong, to admit merely of being drawn tight enough to compress firmly the coats of the vessels, or cut the internal and middle coats, is that commonly used, and in the author's opinion entitled to the most decided preference. A ligature too large in proportion to the size of the vessel, does not close it effectually, and is more liable to slip; and provided it should not slip, does not cut through the parts embraced in the loop, till long after the vessel is thoroughly obliterated, when, from its presence being no longer needed, it becomes a source of useless irritation. On the other hand a ligature relatively too small, by embracing but a narrow line of the vessel, might detach itself too early so as to occasion secondary hemorrhage. For the largest class of vessels usually operated on, such as the femoral, brachial, or axillary, a single strand of the saddler's sewing silk will be found of the proper size. For the larger trunks, such as the innominate, the iliacs, or the aorta, a round cord of greater dimensions is considered more appropriate.

Various other kinds of material have been employed. Animal ligatures, made of various substances, but especially of kid skin rolled into small cords, were employed by Physick, Dorsey, and Jamieson, under the belief that the knot would soften, and become absorbed after it had been applied a sufficient length of time to obliterate the vessel, so as to offer no obstacle to closing of the wound by first intention. Dr. Paul Eve, Prof. of Surgery in the Medical College of Georgia, has employed with the same views, fibres from the sinews of the deer. Experiments with the metallic ligature have also been successfully made upon the arteries of the inferior animals.*

The *instruments* required in the application of the ligature after operations, consists of a *tenaculum* or hook, and a pair of dissecting or proper catch artery forceps. The *tenaculum* suiting best usually for the smaller branches, the orifices of which are not very obvious on the bleeding surface, and have to be taken up with some of the surrounding cellular tissue or muscular fibres. The forceps answers for the larger vessels, the mouths of which are usually conspicuous, and into each of which one point of the instrument can be introduced so as to seize the vessel firmly and draw it out from the nerves and veins that usually accompany it. In parts which are inflamed, the structure of the artery is sometimes found so soft, and occasionally even its investing sheath, as to cut across in the closing of the knot. The *mediate* ligature, as it is called, is then to be applied in the following manner: a thread is to be armed with a curved needle at each end; one of these needles is passed in a semicircle through the tissues at a little distance from

the artery, and the second in a similar manner on the other side of the vessel, coming out near the point where the first entered. The thread thus passed is to be tied on the parts which it embraces, and the bleeding orifice will be found inclosed. Care should be taken, however, to avoid including any nerves in the loop. The same results I occasionally obtain in a more expeditious manner by raising the tissues on either side of the vessel with a couple of *tenacula*, while an assistant throws a ligature round and ties the raised part firmly below. The *mediate* ligature is also applicable in cases where after the arteries are tied a free capillary oozing continues from a part of the surface of the wound, so as to be likely to fill it with blood after the application of the compressing bandage.

One tail of each ligature is to be cut off near the knot, and the other brought on between the lips of the wound; the whole are then to be covered by a greased compress, and secured by the dressings so as to prevent their being unnecessarily disturbed. The ligature is to be left as a general rule till it becomes spontaneously loosened, and can be removed by a slight pull upon the free end. The length of time required for its separation will depend upon the size of the vessel. If any fibrous or other resisting tissue has been included in the loop, the time will be longer in proportion, and it becomes sometimes necessary to hasten its separation by slightly pulling or firmly twisting the thread from day to day. Jones and Travers, in their experiments upon animals, found the temporary application of a ligature sufficient to effectually close the artery. Twelve, twenty-four, or at most fifty hours, according to the latter surgeon, causes an obliteration sufficiently solid to admit of the division of the knot and the removal of the ligature. But there is no object likely to be gained by the removal of a ligature at this early period, that would counterbalance the risk of hemorrhage, to which, to a greater or less extent, it certainly exposes the patient.

Occasionally we find the large artery after amputation so ossified in its structure, as not to close without crushing under the loop. Under such circumstances I have succeeded satisfactorily by plugging the orifice with a piece of linen compress and tying the vessel over it; when the ligature becomes detached it will bring away the plug. Professor Mütter has succeeded in nearly a similar way, by plugging the orifice with a portion of muscle from the detached limb. If the orifice of the bleeding artery is found in the substance of the divided bone, the hemorrhage may be effectually checked by plugging it with a piece of wax or soft wood.

IV. MEANS WHICH HAVE BEEN APPLIED TO THE ARTERIES OF SMALL AND MEDIUM SIZE ONLY.

1st. *Cauterization.*—The eschar produced by the hot iron forms a sort of impermeable plug, adherent to the tissues, and may, as has been before observed, be eminently useful in arresting hemorrhage from the smaller vessels. It is applied in cases of bleeding—from the surface of a bone, from the ranina artery, from the branches of the internal maxillary after operations upon the face, or in cases where bleeding follows the removal of fungous, erectile, or cancerous tumours; or where the coats of the arteries are so softened by inflammation as to tear under the thread, and when the *mediate* ligature is found unavailing to check the flow. For

* Vide paper, by Dr. Levert, in the Amer. Journ. Med. Sciences for 1829.

an artery of medium size, as the radial or anterior tibial, it is necessary to repeat two or three times in succession the application of the iron, in order to form a plug sufficiently firm to arrest the blood during the period required for the obliteration of the cavity by adhesive inflammation. 2. By *tearing or rupture*.—It is well known that where arteries of considerable size are torn off by mechanical force, as in the lacerated wounds produced by machinery, but little bleeding follows. This is owing to the external coat being drawn out into the form of a cone, and forming when it snaps several spiral turns, which offer resistance to the passage of the blood, while the two inner coats, broken at different heights, curl inwards so as to form little septa, between which the blood forms itself into a clot. This process is occasionally imitated by surgeons in the tearing out of large tumours from their beds in the cellular and vascular spaces, after they have been exposed by a superficial incision. In this way, tumours of great size have been removed with but little hemorrhage. 3. *Pinching or mashing* the walls of a vessel for a little distance from its bleeding orifice with a pair of toothed forceps, causes in a similar manner the laceration and shriveling of the two inner coats. This process is found of useful application in many plastic and other operations, when it is desirable to avoid the irritation arising from the presence of the ligature. 4. *Inversion with rupture of the two internal coats*.—This is effected by Amussat by seizing the artery between two pairs of forceps, one of which is to be placed transversely and the other applied lower down in the direction of the vessel, as shown at Pl. 5, fig. 5. With the lower pair of forceps, the two inner coats are ruptured, and the fragments, pressed or stuffed upwards as it were, into the cavity of the vessel. It is a process, however, deserving of but little reliance. 5. *Torsion*.—This may be employed on arteries of small calibre with far greater prospect of success. *Process of Amussat*. (Pl. 5, fig. 7.)—The artery is to be isolated and drawn out so as to expose it for half an inch above the free surface of the wound. With the narrow round pointed

forceps it is then to be seized transversely on a level with the wound and mashed so as to rupture its two inner coats, while the proper torsion forceps are applied transversely on the free end of the vessel to hold it drawn out. With the latter a half turn of the vessel is given so as to twist it on the first pair of forceps which holds it tight. The torsion forceps without loosening its hold is then to be brought down in the direction of the vessel, and the artery twisted upon its axis from three to eight times, according to its size. The upper pair of forceps is then to be removed, and the operation is completed by sinking the twisted end of the vessel into the flesh with the other pair. *Process of Fricke*. (Pl. 5, fig. 8.)—This is much more simple than the above. It consists in isolating the artery so as to expose half an inch or more of the end by pushing back the tissues which cover it, in order to grasp it with the thumb and fore finger of the left hand. The end is then to be seized with a pair of forceps and twirled eight or nine times completely round. 6. The *Seton*. (Pl. 5, fig. 11.)—To complete the description of these various processes, which we owe to the ingenuity and the desire to originate something novel on the part of various surgeons, it may be necessary to mention the following. It has been proposed to make two openings in the side of the vessel just above its open mouth; the free end of the vessel is then to be folded and pushed into the cavity with a pair of delicate forceps, and made to protrude on each side through the slits. It is a process long and difficult, and, as it could only be performed on a vessel of large calibre, deserving of no confidence.

Several of the various processes above detailed for arresting hemorrhage after operations, may be found occasionally useful in practice; but the surgeon who would wish to leave his patient with the nearly positive certainty that he will not be troubled with secondary hemorrhage, should tie the vessels. In regard to the use of refrigerants, astringents, styptics, absorbents and cauterizing substances for the arrestation of capillary bleeding, the reader is referred to the usual treatises on surgery.

PART SECOND.

GENERAL OPERATIONS:

OR THOSE PRACTISED WITH REFERENCE TO ONE OR MORE PARTICULAR TISSUES.

UNDER THIS GENERAL HEAD ARE CONSIDERED: 1. THE OPERATIONS WHICH ARE PRACTISED UPON THE VEINS; 2. THOSE FOR LIGATURE OF THE TRUNKS OF THE ARTERIES; 3. THOSE FOR DISEASES OF THE BONES AND JOINTS; AND, 4. AMPUTATION OF THE LIMBS.

I. OPERATIONS UPON THE VEINS.

THE operations that are performed upon the veins consist of those for phlebotomy, which have already been described; those for the transfusion of blood; and of various processes for the cure of varicose veins, and the troublesome ulcers to which these affections give rise.

TRANSFUSION OF BLOOD.

The wound of an artery, the rupture of an aneurismal tumour, and various other causes, may give rise to such sudden and excessive loss of blood, as to leave the heart without a supply of fluid sufficient to maintain it in proper action. Under such circumstances, it has been proposed to make a transference of blood from the system of another individual into that of the patient. This custom, which was formerly much in vogue, had until lately been completely abandoned. The favourable results obtained by its experimental employment on animals, and the benefit arising in some cases from its use on the human subject, render it proper that the processes for its performance should be briefly mentioned.

Operation.—The instruments usually employed consist in the ordinary ligature for venesection, a scalpel, a thumb lancet, a pair of forceps, and a small metallic syringe, perfectly clean and furnished with a shifting tube or pipe. The orifice of the tube which receives the nozzle of the syringe should be large, and to make the operation more rapid, the parts should be made to fit tight without screwing. Having all the apparatus prepared and at hand, a ligature as for phlebotomy is applied both upon the arm of the patient and the individual from whom the blood is to be

taken. The largest superficial vein found in the bend of the elbow is to be exposed on the patient by a longitudinal incision isolated by careful dissection, and raised upon a probe. At the upper and lower part of the wound the vein should be compressed by an assistant, while the surgeon opens it in the middle by a longitudinal incision: the pressure at the upper part is for the purpose of preventing air from entering the circulation, and that at the lower of avoiding any effusion of blood. Into the opening of the vein, it is advised to insinuate next the small end of the metallic shifting tube, the larger end of which is prepared to receive the nozzle of the syringe; both instruments being raised to near blood heat, by having been previously placed in water of the proper temperature. The ligature on the arm of the patient is then to be removed; the pressure being still kept up with the fingers of the assistant. The tube in the vein is then ready to receive the pipe of the syringe, when the latter has been charged with blood from the veins of the other individual.

A better process, inasmuch as it would be less likely to injure the coats of the vein, and more effectually obviate the possibility of any introduction of air, would, as it appears to me, be the following: Take a caoutchouc tube, one end of which shall by trial be found to enter the orifice of the vein, attach to its larger end a metallic pipe that may in a moment be affixed to the nozzle of the syringe, to which it should closely and securely fit. Then withdrawing the piston of the syringe, (this instrument having been previously raised to the proper temperature,) receive into its cavity about four ounces of blood taken in full stream from the arm of the healthy individual. The operator then adjusts the piston, attaches quickly the metallic extremity of the caoutchouc tube to the nozzle of the syringe, holds the instrument with the

handle downwards till by pressing up the piston he expels all the air from its cavity, and finds the fluid appear at the mouth of the caoutchouc tube. The instrument is then brought horizontal, and the end of the flexible tube insinuated into the opening of the vein, and carried on, above the upper point at which the vessel is compressed; the assistant shifting his finger so as to renew the compression upon the vein and tube. The operator then injects the blood gently into the vein, so as to avoid any sudden shock as it reaches the heart, an assistant at the same time making gentle friction with the finger towards the armpit along the course of the vessels. The process thus described in detail to render it intelligible, should be executed without a moment's loss of time, lest the blood should chill or coagulate in its transit. It is necessary to warm the syringe as above directed, but care must also be observed that it does not much transcend the proper temperature, as the excessive heat might curdle the serum. Another danger to guard against is the introduction of air, as this in all probability would be attended with fatal consequences. This accident has not, however, taken place in any of the cases reported, and may be readily obviated by observing the precautions mentioned. As a further measure of protection, and especially if there was any dribbling of blood from the end of the caoutchouc tube, this might be flattened by pressure between the thumb and fore finger, and thus inserted into the vein. The introduction of four ounces of blood has usually been found sufficient to prevent death from anæmia; but if this amount did not produce the requisite effect, the process might be repeated. The wound in the skin is to be afterwards closed, so as to cause it to heal by the first intention. The injection of medicated fluids into the venous system has been practised according to the same method, though it is questionable that any case can arise that would justify the measure.

Dr. Blundell, who may be said to have revived this operation in England, invented an apparatus for the purpose of transfusing the blood in an almost continuous stream, which, as it has been modified by the makers, consists of a syringe, to which a tubule and basin are permanently attached. It is employed in the following manner, and should be preferred when at hand to the more ordinary instruments described above. The blood is permitted to flow into the brass basin attached to the extremity of the syringe. As it accumulates in the basin, it should be absorbed by raising the handle of the syringe, and then propelled onwards through the tubule attached to it. When the air has all been expelled from the tubule, and blood unmingled with any bubbles issues from the end, the beak should be inserted in the vein. The blood is then to be alternately drawn up from the basin and propelled into the vein, not more than an ounce and a half ever being permitted to accumulate in the basin. This process should be steadily and gently performed, the operator watching from time to time the expression of the patient's countenance, and if unpleasant symptoms occur after two or three ounces of blood have been transfused, the proceeding should be suspended for a moment to allow them to subside. Dr. Blundell thinks that seldom more than half a pint or a pint of blood can be needed. A case has recently been reported by Dr. J. C. Prichard,* in which a pint was successfully transfused at a single operation.

* Prov. Med. Journal, cited in Phil. Med. Examiner, Sept., 1843.

VARICOSE VEINS. (PL. V.)

The permanent dilatation of the veins is known under the name of *varix*, the most frequent seat of which is in the lower extremity. It is attended by various forms of pathological alteration. In the varicose vein, there may be either a simple dilatation without change of texture, or a dilatation with thinning of the coats; or there may be a general or partial thickening of the coats, with elongation of the vessels so as to cause them to assume a flexuous direction. The valves are sometimes so thickened and enlarged as to form pouches across the cavity of the vessel in which the blood lodges and becomes coagulated, and in which also small rounded osseous bodies occasionally form, known under the name of *phleboliths*.

A great number of processes have at different times been employed in the treatment of this affection, viz., *compression, ligatures, suture, resection, section, incision, excision, and cauterization*.

COMPRESSION.—Simple compression is but a palliative measure, and if employed at an early stage, and habitually continued, will check the progress of the disease, so as to render it a source of but little inconvenience. In the old and infirm and in individuals with much constitutional irritability, compression is almost the only means of relief to which the surgeon can with propriety resort. It is made with a laced stocking, or a roller bandage, neatly and closely adjusted to the limb, and extended from its extremity to a little above the upper limits of the affection. Surrounding the limb with a succession of adhesive straps is a measure that has also been occasionally employed for this purpose.

Compression with the immovable apparatus applied as in the treatment of fractured limbs, has been employed by Mr. Teale, of Leeds, Eng., and alleged to have been successful in effecting a permanent cure.

Compression at several points, so as to close the vessel by adhesive inflammation. (*Process of Sanson*, Pl. 5, fig. 1, c.)—The instrument employed by this surgeon consists of two small parallel plates forced together by a screw. Between these two plates the vein, raised in a fold of skin, is to be placed. The pressure made with the screw should be but moderate, and at the end of twenty-four hours shifted to another portion of vein, in order to avoid producing mortification. Several cases of successful treatment by this method have been reported. It is, however, but little used. The same process has been applied to the veins of the cord and scrotum.

Compression after incision. (*Process of Delpêch*.)—This consists in laying bare the vein by a longitudinal incision an inch long, and gliding below it a piece of prepared spunk over which the vein is to be flattened by the application of two adhesive strips, with the object of causing its sides to unite by adhesive inflammation. This process has been but little employed, and is little deserving of confidence.

Compression over a pin or needle. (*1st Process of Davat*, Pl. 5, fig. 1, a, and fig. 3.)—Raise the vein in a fold of skin, through the base of which and below the vein a pin or needle is to be passed transversely. Around this needle is to be wound a hare-lip suture, sufficiently tight to keep the anterior and posterior surfaces of the vein in close contact. Several pins, from four to ten or twelve, should be employed at little distances from each other, upon the main trunk and its principal branches, so as to cut

off effectually the route of the blood through the superficial veins, and cause it to return by the deep-seated. Velpeau prefers to surround the two ends of the pin merely with the thread in vertical turns (Pl. 5, fig. 1, No. 2,) rather than in the form of a figure ∞ , as it is less disposed to cause ulceration of the skin. An elliptical wrapping of the pin, however, as shown at fig. 4, is decidedly preferable to either.

2d Process of Davat.—After the introduction of one pin, as above described, a second is to be entered a little lower, perpendicularly *through* the skin and both surfaces of the vein; it is to be carried in the direction of the vein under the first pin and brought on the opposite side, piercing a second time the two surfaces of the vein and that of the skin. The two pins are at right angles with one another, and are each to be wound with the hare-lip suture.

In my own practice, the first process has answered best. When the vein, as for instance the saphena on the thigh, is covered by a layer of superficial fascia, it is difficult to raise it up so as to pass the second pin readily in the prescribed longitudinal direction. Its effect also has appeared to be rather injurious than otherwise in producing two transverse folds of the vein, which keep the sides from coming so well in contact as when the single pin or needle is passed across and covered with a compress and bandage. From the sixth to the tenth day the obliteration will be usually found complete, and the pins may be removed. I have several times employed two or three separate pins in this way, upon the saphena along the inner face of the thigh, when the enlargement of the vessels had extended from the leg upwards upon this region; while others were introduced concurrently upon the vessels of the leg. In no instance have I failed by this method to produce a cure, or very marked amelioration. A bandage wound tightly on the extremity from the groin downwards, and perfect rest in the horizontal position, were the means employed to guard against the supervention of phlebitis, which, as reported by Velpeau, Lallemand, and Serres, has in some instances been attended by fatal consequences.

This process, in the opinion of the author, is greatly to be preferred to any of the other modes of operation, so perplexing by their number, which have been devised for the management of this troublesome affection.

SUTURE. (Process of Fricke.)—This consists in passing a needle in a longitudinal direction, so as to twice traverse the coats of the veins, as in the introduction of the second needle of Davat. The needle is to be drawn through at once, so as to leave a thread in the wound, over which a compress and bandage are to be applied. In two days, according to Fricke, a coagulum forms so as to obliterate the vein. This process has been received but with little favour, and has only been in a few instances employed.

ACUPUNCTURATION.—Little more value is attached to the process by acupuncture with a fine needle, employed by Lallemand. The needle is passed through both sides of the vein, making of course two punctures in the skin. It is to be left in from two to six days, or in fact till the parts around it become swollen and reddened, and the vein is felt more compact and cord-like. The irritation of the needle is said to cause in the first instance a coagulation of the blood, and finally an effusion of

lymph, which obliterates the vessel. In large trunks the simultaneous introduction of two other needles is advised.

LIGATURE. (Process of Sir E. Home and Beclard.)—The principal trunk of the diseased veins is to be exposed at its most superficial position and tied like an artery. The vessel is then to be divided above the knot. Others leave the vessel uncut; some surround it with two ligatures, and remove a portion of the vein between them. It has even been directed to divide the vessel transversely with a cut from within outwards through a fold of the skin, and then to draw out the upper portion of the divided vessel with the forceps, and tie it; the bleeding from the lower to be checked with a compress and bandage. Fatal results have but rarely followed the application of this process; but as the vessel is interrupted only at one point of its course, the other superficial veins are disposed to enlarge subsequently, so as to render the relief only temporary. In operating upon the saphena, near the bend of the knee, it is necessary to avoid including in the ligature the accompanying nerve.

As the clot in the veins becomes thoroughly solidified, according to Mr. Wise, in forty-two hours after the operation, he has proposed to diminish as much as possible the irritation arising from the ligature, by tying it with a running knot, (Pl. 4, fig. 2, No. 5,) and removing it as early as twenty-four or thirty-six hours after its application.

Various plans have also been proposed for the subcutaneous obliteration of the veins by ligature; these will be described under the head of Varicocoele, to which the method is commonly considered more appropriate.

RESECTION without ligature.—After the vein is exposed by a longitudinal incision, it is to be isolated and cut across at the two extremities of the wound, and the separated portion removed. The retraction of the two ends of the vein under the skin, preserves them from the contact of the air, and exposes them less to the risk of inflammation than when ligatures have been applied.

SECTION.—The section of the vein may be made by one of two processes. 1st. By simply dividing across, the vein and the fold of skin raised with it, or by introducing the knife flatwise by a puncture between the skin and vein, turning the edge backwards and dividing the vessel by a subcutaneous cut. The latter, which is the process of Sir B. Brodie, was devised for the purpose of preventing the introduction of air, which he supposed to be the common cause of the phlebitis that occasionally followed section by the former method. It has been lauded by many English surgeons; but experience has shown that it is not altogether exempt from this danger. When the skin is cut across at the same time with the vein, the blood should be pressed out from the vessel, and the wound dressed flat with charpie or lint. The suppurative inflammation which follows causes the obliteration of the vein. Of forty cases in which this method was employed by Velpeau, death followed but in one.

The section, to be effectual, must be made on all the separate knots of dilated veins.

INCISION.—This method differs from the preceding chiefly in the direction of the cut, which is longitudinal. It has been employed only in cases, where from the great number and size of the enlarged veins, the knots were of unusual dimensions, and not amenable to other modes of cure.

Multiplied incisions. (Pl. 5, fig. 2, No. 7.)—Two circular ligatures are to be applied over the skin, above and below the dilated mass of veins. Several incisions with a lancet, one to two inches long, are to be made through the skin and outer wall of the veins, so as to allow them to be completely emptied of the coagulated blood they contain. The wounds are then closed with adhesive straps, and compression made immediately with a roller bandage, in order to flatten the veins and prevent their filling anew with blood.

Single incision. Process of Richerand. (Pl. 5, fig. 1.)—The skin and walls of the tortuous varicose veins, are to be divided longitudinally with a convex bistoury, down to the aponeurosis. The length of the incision required, will be varied according to the extent of the disease, from three to six or seven inches. The coagula of the veins are to be forced out by pressure, and the wound filled with lint, which is to be retained by a roller lightly applied. At the end of three or four days the dressings are to be removed; the veins will then be found obliterated. The wound is to be dressed afterwards as under ordinary circumstances. The enormous wound occasioned by this process is frightful to the patient, and more or less liable to be followed by phlebitis or phlegmonous erysipelas. It does not admit of the immediate application of a compressing bandage, like the process by several small incisions, which is clearly entitled to a preference as being less dangerous and equally successful.

Excision or extirpation.—This should only be employed, if at all, in circumscribed masses of the convoluted veins of the leg, which can be isolated and removed without involving the larger venous trunks. If the skin is sound, it is to be raised in a transverse fold over the vein, and divided with the bistoury from within outwards. The vein is then to be cut across at the two ends of the incision, and compression with a ribbon made below in case the flow of blood is troublesome. The mass of dilated and convoluted veins is next to be dissected out. If the skin is adherent to the vein, an elliptical incision is to be made, so as to remove the diseased portion of it with the latter.

Cauterization. This was practised by the older surgeons, who made use of the heated iron. Latterly, the caustic potash has been much employed for the purpose by MM. Gensoul, Bonnet, and several English and American surgeons. The process is effectual, but painful and tedious; and if the disease is so extensive as to require the application of the caustic on many points, it is liable to be followed by œdema of the limbs. It is alleged, however, that it is less frequently succeeded by a relapse, from the reopening of the channel of the vein at the places where it had been previously obliterated, than any of the other processes for the same objects which have been noticed. M. Gensoul limits, and it appears to me with propriety, the use of this means to cases in which there is ulceration of the part attended with hemorrhage. M. Bonnet employs it as his usual treatment.

Process of Bonnet.—The directions given by this surgeon are, to apply upon the track of the vessel, as in forming an issue, several portions of the caustic, at points three or four inches apart, and where the vein is found overlaying a muscle. The application of the caustic over the bony or fibrous structures might be followed by troublesome ulceration. It should not, therefore, be made below the middle third of the leg, nor above

the middle of the thigh. Two successive applications of the caustics are required upon the same site to reach the vein, since the use of a single piece sufficiently large to open the vein would produce too extensive a destruction of the skin. The first application is to destroy only the skin and cellular tissue, without interrupting the course of the blood in the vein. The second application is to be made upon the centre of the eschar three or four days after the first, and if the vein lies deep, the eschar should be previously cleft with the knife. When the second slough comes away, the vessel is found laid open, and some hemorrhage follows. The inflammation which attends the cure of this adventitious ulcer blocks up the vein. No other precaution is needed as a guard against the occurrence of phlebitis than confining the patient to his bed. This process, according to its author, generally succeeds in the adult, but has failed in the cases of old men.

If the plan of cure by caustic is adopted, it will be found more rapid, certain, and less painful, to adopt the following process of M. Laugier, viz., to make an incision over, but *without opening the vein*, so as to expose its walls for about half an inch. The incision in the skin should be about an inch long. A piece of greased lint with a longitudinal fissure in the centre, is then to be laid over the wound, and through this opening a piece of stiff Vienna paste, (see page 21,) half an inch square, and tapered on one side into a wedge, is to be passed with its thin edge between the lips of the wound, so as to rest firmly upon the vein. The loose ends of the lint are then to be turned over the back of the wedge and fastened down with a strap of adhesive plaster. The pain is over in about half an hour, and is not severe. In a case in which this practice was successfully employed by Mr. Clay, of Manchester, England, a large slough was formed in three days, and was thrown off under the use of poultices at the end of fourteen.

II. OPERATIONS UPON THE ARTERIES.

LIGATURE OF THE ARTERIES IN THEIR COURSE. (PL. VIII.)

General observation.—An artery is tied in its course, for the purpose of arresting the flow of blood along the trunk of the vessel, beyond the place at which the ligature is applied. It is practised occasionally for incised or gunshot wounds, when the retracted ends of the divided vessels without ceasing to bleed are so masked by effused and coagulated blood, that they cannot be seized with the forceps or tenaculum; when an artery is lacerated by the sharp edge of a fractured bone; in cases of secondary hemorrhage from the face of the stump not otherwise controllable; in continuous bleeding from the cavity of a wound, left by the ablation of tumours; but more frequently than all, for the cure of the various kinds of aneurism. It is the larger vessels only that in this way become the subject of operation. These are usually lodged, for the greater part of their course, in the interstices between particular muscles, and have definite rules as regards their origin and direction, which are subject only to occasional variations, well defined in the different treatises on anatomy. Each artery is composed of three tunics—one of them, fragile and polished, called the internal or sero-mucous—a second, fibrous,

contractile and yielding, called the middle or elastic—a third, forming a dense, compact envelope, closely embracing the latter, called the external or cellular coat. The artery is attended by one or two satellite veins, and very commonly by a nerve. These are again immediately surrounded by a general cellular sheath, which, with the parts it contains, is lodged under one, two or more of the layers, called fasciæ or aponeuroses.

Three objects are to be held in view in the operation for tying an artery, in its course. 1st. To uncover the common bundle formed by the artery, veins and nerve. 2d. To isolate the artery from the accompanying parts; and 3d. To place the ligature round the artery.

1. To expose the sheath of the vessels.

a. When about to commence the operation, the surgeon from his knowledge of the structure of the parts, is to figure out in his mind's eye the exact position of the vessel, and the depth at which it runs. He should make the muscles contract, between which he is to cut down upon the vessel, in order to discover the real line of their interstice, as this is found to vary according to the different degrees or development of the muscular system. If the artery be superficial it may be traced by its pulsations. If too deeply placed for this, its prescribed course may be gently traced on the skin with the handle of the scalpel, or, if need be, marked with ink, and the operation proceeded with according to the rules

PLATE VIII.—LIGATURE OF THE ARTERIES IN GENERAL.

This plate exhibits under their several heads the successive steps of the surgeon in the common method of tying the vessels. The success, safety, and neatness of the operation, will depend to a great degree on the surgeon rendering himself familiar with the processes by practice on the dead body, and following them closely in the order indicated in the figures, in his operation upon the living.

Fig. 1.—Incision of the skin.

In the drawing, the incision of the skin is represented as made with the bistoury in the first position. The common scalpel in the third position, as has been before observed, answers fully as well for this purpose.

a. The wound, which should extend only through the skin and superficial fascia. b. Bistoury in the first position.

Fig. 2.—Incision of the superficial aponeurosis upon a grooved director.

a. Bistoury held in the second position, cutting edge upwards, dividing the aponeurosis. b. Grooved director. c. Wound.

Fig. 3.—Separation of the muscles.

a. Ring and middle fingers of the surgeon's left hand. b. Fingers of an assistant placed on the opposite side of the limb, drawing the muscles out of the way, on that side of the wound. c. Grooved director held in the right hand; with this the surgeon tears the intermuscular tissue, till he brings into view the sheath of the vessels at the bottom of the interstice.

Fig. 4.—Opening the sheath of the vessels.

a. Dissecting forceps held in the surgeon's left hand, and elevating a portion of the sheath of the vessels. b. Bistoury held in the seventh position, incising the base of the fold. Without relaxing his hold of the forceps, the operator next lays down the bistoury, and takes the grooved director in order to enlarge with its point the opening in the sheath as seen at fig. 5.

Fig. 5.—Isolation of the side of the artery next the operator.

a. Sheath raised with the forceps in the left hand. b. One-half the diameter of the artery exposed by breaking with the point of the director the cellular tissue by its side.

Fig. 6.—Isolation of the opposite side of the artery.

a. Sheath raised on this side with the forceps. b. Grooved director used for the same purpose as in fig. 5. As soon as the vessel is isolated on this side, the hand is inclined so as to pass the point of the director under it in the direction of the operator. This is the most important step of the operation, as great care is required to avoid all injury of the accompanying veins, nerve, or of the artery itself, and to raise the latter only, astride of the instrument. The curved aneurismal needle is occasionally employed instead of the director, and especially for deep-seated vessels.

Fig. 7.—Introduction of the eyed probe, threaded with the ligature.

This is required in case the grooved director has been used to raise the vessel. The eye may be near the probe point, or at the opposite end. If near the point, the instrument may be only passed part way under the vessel, and one end of the ligature drawn out with the forceps or blunt hook, the other end of the ligature becoming detached as the probe is withdrawn.

Fig. 8.—Elevation of the artery in the loop of the thread.

This step is employed merely as a precautionary measure, in order that the operator before tying the thread may assure himself by a circular inspection of the artery, that it alone is enclosed in the loop.

Fig. 9.—Double knotting the ligature.

The drawing represents the uniform action of both hands on each extremity of the ligature, and the mode of applying the thumbs to increase the tightness of the knot.

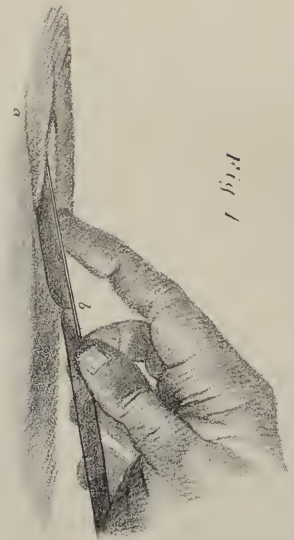


Fig. 1

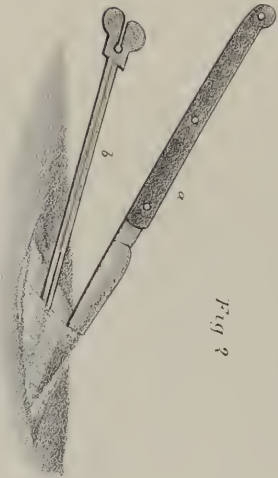


Fig. 2



Fig. 3

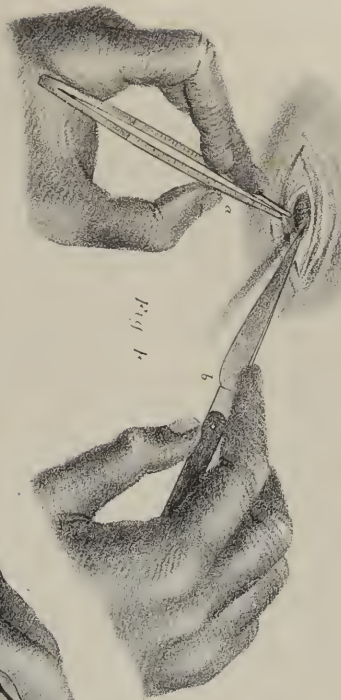


Fig. 4

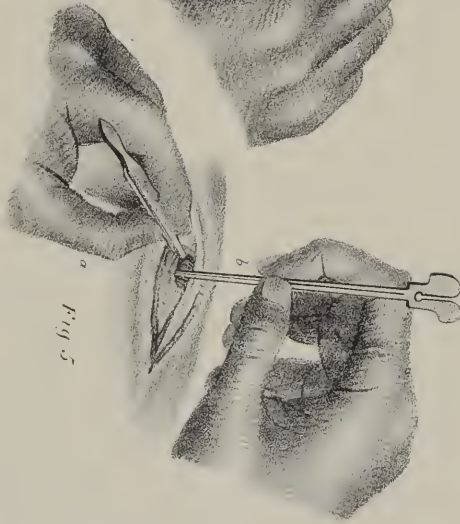


Fig. 5

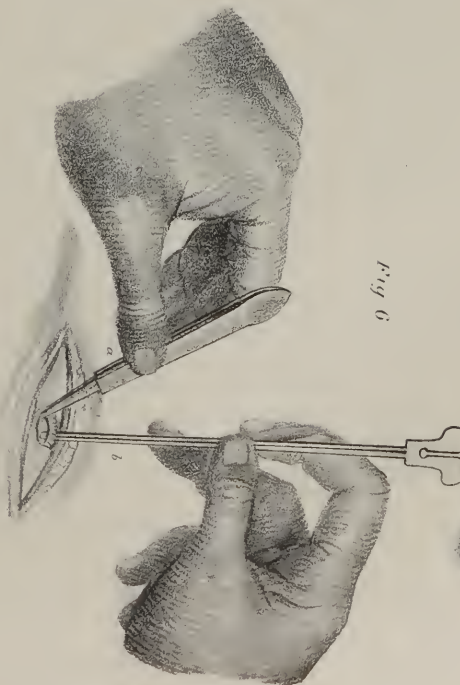


Fig. 6

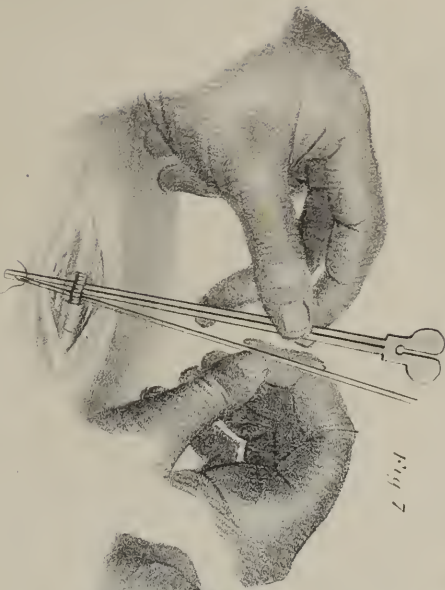


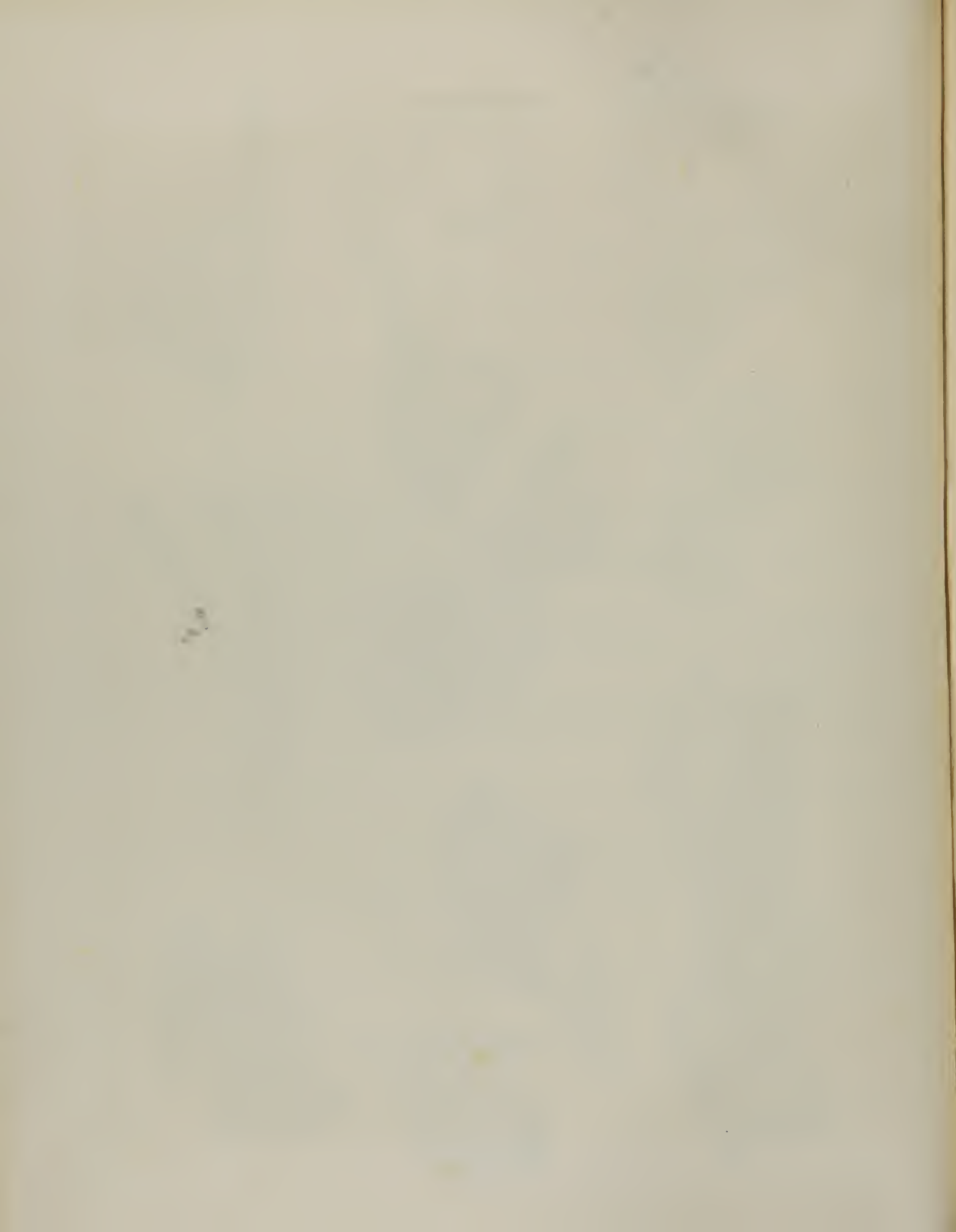
Fig. 7



Fig. 8



Fig. 9



which are laid down in each case with almost mathematical precision. It is prudent also in most instances, before and during the operation, to determine by the touch whether there be any neighbouring or anomalous branch in the way, which, if such should be the case, it would be desirable to avoid. The tourniquet or other means of compression need not usually be applied; as, by interrupting the pulsation, it would destroy a useful guide to the discovery of the vessel. But if a large artery is to be tied, and the surgeon has not had experience in the particular case, it is a useful measure of precaution, and may be tightened during the operation in case of sudden hemorrhage. If, however, the operator intends to open the sac of an aneurism, turn out the blood and apply a ligature to the vessel above and below the tumour, it is a step which should not be neglected.

b. The integument is now to be opened. If the artery be superficial, the skin should be incised directly over its track. If it be somewhat deep, it is better, as giving a greater certainty of falling upon the muscular interstice, to divide the skin, after the direction of Lisfranc, somewhat obliquely over the course of the vessel. Having decided upon the most accessible or appropriate point for operation, the surgeon, making the skin tense in the ordinary manner without altering its relation to the artery, divides it carefully from without inwards, with the scalpel, for an extent of two to four inches, according to the depth of the vessel from the surface. Or, placing his thumb and fore finger on the course of the vessel, raises up with the aid of an assistant a fold of skin, and divides it from within outwards, with the bistoury entered at its base. By raising up one lip of the wound with the thumb and finger, the incision can then be readily enlarged to the requisite extent. This latter plan is not applicable in all parts of the body, for where large superficial veins exist along the line of incision, they run a greater risk of being wounded by this method than by the incision from without inwards. It has been suggested by M. Lisfranc, that the ends of the fingers of the left hand should be placed vertically over the line of the vessel, and the incision made along their dorsal edge. This method I have found very satisfactory in practice. Care, however, must be observed to make the pressure directly down upon the pulsating vessel so as not to disturb the relations of parts, and confuse the subsequent steps of the operation.

c. The fascia superficialis, and the superficial aponeurosis, which cover even the most superficial of the trunks that require a ligature, are next to be opened. These may be divided, if the vessel be deep, directly over its course with the knife; if superficial, slightly to one side. But it answers equally well, and is safer and surer, to make a small puncture through these membranes at the lower end of the wound, push in the grooved director so as to raise them up one at a time, and having observed that there is no superficial vein or nerve in the way, run the knife along the channel in the instrument the whole extent of the incision of the skin. If the artery be superficial, it is now seen in its sheath; if deep, we must seek the proper muscular interstice, according to the rules given in each case, open it by breaking the cellular tissue with some sweeps of the finger, the point of the director, or the handle of the scalpel, and, if need be, with a few touches of the edge, until the shining surface of the second aponeurosis which covers the deep vessels is brought into view; this

is then to be opened in like manner as the first or superficial aponeurosis. If the tension of the superficial fasciæ presents an obstacle to the separation of the muscles, it may be cross cut with the scalpel at the ends of the wound. If the surgeon follow methodically each of these steps, avoiding all precipitancy in searching for the vessel, he will accomplish his object in a short space of time, and with great certainty and safety.

2. *The isolation of the artery.*

a. The lips of the incision are to be held asunder with the fingers of an assistant, or a pair of blunt hooks, and the blood removed from the bottom of the wound by pressing in a sponge wetted with cold water. If compression has been employed on the main trunk of the artery, it is to be slackened in case of doubt as to the position of the vessel, in order to render this evident by its pulsation. When the sheath of the vessel is fairly exposed, it is to be raised with a pair of forceps over the artery, and opened by a horizontal cut with the point of the knife, the edge of which is to be held so that no accidental slip will endanger the parts below. Without loosening the hold of the forceps, the end of the grooved director is entered at the opening thus made. If the sheath be found too resisting to be readily torn with the point of the director, it is to be raised on this instrument and slit for a few lines along the groove with the scalpel or a probe-pointed bistoury. Then breaking cautiously the cellular tissue on either side of the artery, so as to separate it from the veins and nerve, the operator passes the point of the grooved director below and brings it out on the opposite side of the vessel. This last step is the most difficult part in the isolation of the vessel. The end of the fore finger of the other hand should be placed at the point of emergence, so as to present resistance to the instrument, and push out of the way the nerve or vein, in order that neither may be contused or raised with the artery. If the cellular tissue, which is pushed before the director, does not yield to its point, it may be nicked with the edge of the knife. If the vessel be superficial, the director is to be carried at right angles to it. If somewhat deep, it should be passed rather obliquely to its course, the deeper sides of the wound offering less obstacle in that direction: at the same time the instrument should be bent near the end; the common silver or steel director being sufficiently flexible to take any curve requisite for the occasion. But in vessels still deeper placed, as the posterior tibial, iliac, and subclavian, some one of the various kinds of curved aneurismal needles must be employed.

3. *Application of the ligature.*

Having ascertained, by careful examination, that the artery alone is raised on the director, a common eyed probe, threaded with the ligature, and slightly bent upwards at the entering end, is passed along the groove of the instrument. This end of the probe is to be seized with the thumb and fingers, or a pair of forceps, and carried through, at the same time that the director is withdrawn in the opposite direction. If the ordinary aneurismal needle be employed, no director is required; the ligature, which is carried near the point, is passed with the instrument under the vessel, and is to be seized on the opposite side with the forceps. A very admirable instrument for securing deep-seated vessels, on

the plan of Belloccq's tube, has been devised by Professor Gibson, of the University of Pennsylvania. Professor Horner, of the same institution, employs an instrument shaped like the shoemaker's awl, notched near the point for the attachment of a ligature with a slip-knot. Many surgeons employ the needle of Mott, which unscrews near the end, so that the beak may be detached and drawn through with the ligature. Various other aneurismal needles will be shown in connection with the plates, the two best of which, according to my own experience, is that of Graefe, which is curved on the side; and that of Physick, consisting of a blunt-pointed needle, held in the artery forceps of that surgeon, a drawing of which is given in the operation for suture of the palate.

b. Knotting the ligature.—Having raised the artery by drawing on the two ends of the ligature, to see whether it arrests the pulsation below, and thus avoid all possibility of a mistake which has sometimes been made—that of tying a nerve instead of the artery—the ligature is to be firmly secured with the common double knot. It should be tied directly across the vessel, for if the direction of the loop be oblique, it might, by descending on one side, become so loose as not sufficiently to compress the artery. If the vessel lay at the bottom of a deep and narrow wound, each fold of the knot should be firmly tightened by the ends of the fore finger of either hand passed down, back to back, upon the artery; a method which will be found in almost every case superior to the use of any of the complicated *serre-neuds* that have been invented. It was till recently considered indispensable, for the safe obliteration of the vessel, that the ligature should be tied so tight as to divide the middle and internal coats; and though this is more usually and properly the result, experience has shown that the blocking up of the vessel by the formation of a coagulum and the effusion of lymph, is as completely effected when the inner walls of the vessels are merely held in close but firm contact. Abernethy and John Bell were in the habit of applying two ligatures, and dividing the vessel between them, in order to allow it to retract as an additional precaution against hemorrhage—a practice which is now abandoned.

c. Dressing.—The dressing of the wound should be simple. It has for its object the accomplishment of union as far as possible by first intention. One tail of the ligature is to be cut off near the knot, and the other brought out over the nearest portion of the skin. The French practice of carrying it out at the lower end of the wound is not always the most advisable, as it may, from the length and obliquity of the tract, lead to the formation of a sinuous ulcer. The wound is to be closed with adhesive straps, and lightly secured, when practicable, with a compress and roller. The member is to be placed in a position that will relax the muscles. If the artery tied has been a large one, as for instance the iliac, femoral, or subclavian, the limb, to preserve the vital warmth, should be for a time wrapped with flannel, or what answers better, as serving to prevent the weight of the part from interfering with the enlargement of any of the superficial capillaries, laid upon a bed of loose soft wool. If the loss of temperature in the limb that at first attends the operation be persistent, friction should be made in addition, with a slightly stimulating and aromatic liniment. The ligature is to be left untouched for eight to ten days for the smaller arteries, and for two weeks or more for the larger; and is not in any case to be removed till it follows a very slight

pull, as that is the only evidence we have of its having divided the vessel by ulcerative absorption, and of the probable closure of the calibre for some little distance above. The three principal classes of accidents to be dreaded, are, 1. Those which may result from *plethora*, on account of the mass of blood being confined to a smaller circuit than usual. This is to be obviated by blood-letting and the usual antiphlogistic regimen. 2. *Hemorrhage* about the period of the separation of the ligature. From whatever cause this may arise, it requires immediate compression to be made on the surface of the wound, or over the trunk of the vessel above, or, this not sufficing, the tying again of the vessel, if practicable, at a higher point. 3. *Gangrene*, where the principal trunk of the limb has been tied for aneurism. This disaster has sometimes, though very rarely, been known to follow. It occurs more frequently when the ligature has been required on account of a severe gun-shot wound, compound fracture of a bone, or other severe injury. But it is *more especially* to be dreaded when, in consequence of a previous wound, or from bungling during the operation, the large conducting vein from the limb has been likewise injured, or where an aneurismal communication has been formed between the artery and its accompanying vein. When gangrene, notwithstanding the use of all proper precautionary measures, follows, the only chance for the ultimate safety of the patient is speedy amputation. The rules for the application of ligatures to the different vessels, are as follows.

LIGATURE OF THE DIFFERENT ARTERIES.

OF THE ARTERIA INNOMINATA.

Surgical anatomy.—The arteria innominata is, after the aorta and pulmonary arteries, the largest arterial trunk in the body. It is given off from the top of the arch of the aorta to the left of the middle part of the upper bone of the sternum, and a little more than half an inch from its upper margin. It passes from this place obliquely upwards and outwards, to a point immediately behind the sterno-clavicular articulation of the right side, at the upper margin of which it divides into the right primitive carotid and right subclavian. In its rout it traverses the superior thoracic fascia of Cooper, (which is an important means of protection to the cavity of the chest,) about four lines below its place of bifurcation. The trunk of this vessel is usually found from an inch and a quarter to an inch and a half long. Its diameter, in a well developed adult, is about half an inch. The place of its division is deep behind the sternum, from half an inch to three inches from the inner face of the top of that bone. In front, the vessel is separated from the sterno-hyoid and thyroid muscles by some loose cellular tissue, in which, are lodged many of the inferior thyroid veins that discharge into the left subclavian. Between these and the bone lies one part of great importance, the transverse vein, (left vena innominata,) which passes over from the left to the right side, but so near the root of the vessel; however, as to be out of the way of the operation.

When the head is thrown forcibly backwards and to the left side, the arteria innominata is drawn upwards, so that its point of bifurcation, as seen in Plate 9, fig. 1, is considerably above the

sterno-clavicular articulation. *Posteriorly*, it crosses obliquely the root of the trachea. On its *inner* face is the left carotid, and in the angle of divergence between these two vessels, projects the trachea. *Externally*, it rests for the greater part of its course upon the pleura covering the upper surface of the right lung. The right subclavian and right jugular vein, and the common trunk they form, as well as the pneumogastric nerve, are placed so much on the outer side of the artery at the point where it is tied, as not to be endangered in the operation, unless the surgeon errs by hunting too far outwards for the vessel, which, it is to be recollected, is lodged between the right margin of the trachea and the right sterno-clavicular articulation, immediately behind the sternal origin of the sterno-cleido-mastoid.

Anomalies.—This great trunk is but rarely seen to deviate from the usual description. It occasionally, however, varies in regard to its direction and length, and has been found altogether wanting. I have in my cabinet several specimens of transposition of the great vessels coming off from the arch of the aorta. In one, the right subclavian originates on the left side, and crosses to the right between the trachea and œsophagus. In another having the same origin, it passes behind both these tubes. In a third, the two carotids spring from a common trunk, etc.

Anastomosis.—Spontaneous aneurism of the arteria innominata itself, has many times been met with, and instances have been noted by two observers,* where it was found with one or both of the branches that arise from it, obliterated after death. The anastomosing branches that may restore under such circumstances the circulation to the right side of the head and neck, are the branches of the left vertebral and carotid; the thyroid, cervical, intercostal and internal mammary of the two sides, anastomose together so as to be able to return the blood to the right arm by the way of the supra and sub-scapular, external thoracic and circumflex vessels. The fact of its accidental obliteration serves in a measure to show the *possibility* of a successful result in the case of its being tied. The honour of having first performed this most serious, but as yet unsuccessful operation, is due to Professor Mott, of the University of the city of New York.

Operation. Process of Mott. (Plate 9, fig. 1.)—The patient is placed in the recumbent position, with the neck slightly flexed and supported with a pillow, and the face turned to the opposite side in order to relax the sterno-cleido-mastoid muscle. The surgeon, standing upon the right of the patient, makes a transverse incision of three inches in length, commencing at the median line of the neck, and extended outwards parallel with but half an inch above the upper border of the clavicle. Another incision of the same length is made along the internal border of the sterno-cleido-mastoid, terminating at the commencement of the first. The platysma muscle and the superficial fascia are next carefully opened so as to expose the sternal portion of the sterno-cleido-mastoid, which is to be divided on the grooved director previously passed behind it. The inner two-thirds of the clavicular origin of the muscle is to be cut in a similar manner; the muscle is then to be reversed upwards and outwards, as seen in Plate 9. The sterno-hyoid and thyroid muscles are now to be divided, after having been cautiously raised on the director. The

surgeon then opens with the finger or the director the cellular tissue lying above the vessel, carefully avoiding the right internal jugular vein, which is found a quarter of an inch to its outer side, and the inferior thyroid veins, which usually cover it in front, and are to be drawn off laterally. The finger falls first upon the primitive carotid near its root. The surgeon traces this vessel downward, and cautiously tears the cellular tissue till the innominate is exposed. The vessel in question being now discovered, it is to be separated on its outer or right margin from the vena innominata of the same side with the end of the director, and then pressing off lightly from it the vein and the recurrent laryngeal nerve, the ligature is carried with a curved aneurismal needle from without inwards around the vessel.

In operations upon the subject, I have found it more convenient to make the longitudinal incision first, as the skin becomes relaxed after the transverse one is made. Before attempting to pass the ligature, I find it also best to raise with the forceps and divide on the front of the vessel a dense cellular layer, which is an extension downwards of the deep-seated fascia of the neck. Professor Mott secured the vessel with the ordinary silk ligature.

Several other processes have been devised for the ligature of this artery. Græfe, who followed Dr. Mott in the operation, made only a longitudinal incision, along the inner side of the sterno-cleido-mastoid, and partly with his finger, and partly with the handle of the scalpel, separated the parts down to the carotid near its place of origin. Following this vessel, he reached the innominate, which he detached behind the upper part of the sternum from its sheath, so as to get his finger around it. M. Manec directs only the transverse incision to be made, and through that proceeds to isolate the vessel.

Process of King.—This as last modified consists of an oblique incision, carried inwards and upwards from the right sterno-clavicular articulation over the supra-sternal fossa, to the left sterno-cleido-mastoid muscle, the surgeon standing on the left side. The artery is to be sought for between the trachea and the sterno-hyoid muscles, and surrounded with a ligature passed from without inwards. This process, though brilliant in its execution on the dead body, must be attended with great difficulty in its application to the living, from the contraction of the muscles and the effusion of blood in so narrow a wound. That of Mott is to be preferred to all, as the most judicious in its plan, and leaving less to hazard in the delicate manipulations required.

In each of the several instances in which the operation has as yet been performed, the patient sunk from hemorrhage between the periods of nineteen and sixty days; and it is yet a question whether the great size and depth of the artery, its proximity to the heart, and the probability of its disease in aneurisms of the carotid and subclavian do not present such difficulties in regard to the formation of a clot on the side next the heart by the time the ligature separates, as to offer insurmountable obstacles to its successful performance. In Manec's experiments upon the inferior animals, in which the effusion of coagulable lymph takes place with greater facility than in man, the safe obliteration of the vessel, even when previously healthy, occurred but twice in four times. Still, circumstances might *possibly* arise to justify its performance, especially when it is considered that the only alternatives presented are little to be relied on, viz: the securing of the carotid or subclavian on the

* Pelletan and Dr. Wm. Darrach.

distal side of the tumour after the methods of Brasdor and Wardrop, or the uncertain process of Valsalva.

LIGATURE OF THE COMMON CAROTID—PLACE OF ELECTION.

Surgical anatomy.—The primitive carotid arteries pass out at the root of the neck upon either side of the trachea, placed about an inch apart, and ascend obliquely upwards and backwards in the direction of the angle of the jaw. The higher they ascend the farther they recede from the front line of the neck. On a level with the superior margin of the thyroid cartilage, they divide into two branches, the internal and external carotid. The position of

the head materially influences the relative distance of the angle of the lower jaw from the place of bifurcation. When the head is depressed or the mouth opened, the arteries are covered by the angle of the jaw. When the base of the skull is horizontal, the point of division is nearly an inch below it; and if the head be carried backwards, the distance is of course increased. The right carotid is shorter than the left, and somewhat more superficial near its origin, in consequence of its coming off from the arteria innominata. The left primitive carotid arises from the aorta, and as it passes up the neck, crosses the root of the trachea, is separated from the first bone of the sternum by the vena transversa, and has passing at a little distance behind it, the arched ex-

PLATE IX.—LIGATURE OF THE ARTERIA INNOMINATA AND SUBCLAVIAN.

Fig. 1. (A)—Ligature of the arteria innominata. (Process of Mott.)

The neck of the patient is slightly flexed, the head thrown back, the surgeon standing on the right side. The process for laying bare this great trunk exposes also the origin of the subclavian, carotid, and several other important parts.

1. Triangular flap of the skin and superficial fascia, raised and pushed upwards and outwards.
2. Sternal portion of the sterno-cleido-mastoid muscle, divided and reflected back.
3. Divided tendon of the same portion of this muscle left connected with the sternum.
4. Clavicular portion of the same muscle left undivided.
- 5, 6. Place of division of the sterno-hyoid and sterno-thyroid muscles.
- 7, 8. Upper section of the same muscles retracted and pushed inwards precisely as they appear on the operation upon the dead body.
9. Deep-seated cervical aponeurosis, forming a covering to the artery in front, above which it has been divided on the grooved director—lower section only seen.
 - a. Arteria innominata, raised above the sternum by the head being thrown backwards.
 - b. Origin of the right primitive carotid.
 - c. Origin of the subclavian.
 - d. Anterior edge of the internal jugular vein.
 - e. Thyroid vein crossing to the internal jugular.
 - f. Phrenic nerve crossing in front of the subclavian artery.
 - g. Descendens noni nerve crossing obliquely over the outer face of the carotid sheath to the sterno-hyoid and thyroid muscles.

A ligature is seen applied about the arteria innominata, at the proper place for securing that vessel. Two more are thrown around the roots of the carotid and subclavian, showing the manner in which these vessels may be secured by the process of Mott for tying the arteria innominata.

Fig. 1. (B).—This represents a similar opening of the integuments and soft parts as in fig. 1, A, with an exposure of the roots of the vessels that come off from the subclavian near its origin, a ligature being placed below each, to show the possibility of tying them in case of accident.

1. Line of the transverse wound at the root of the neck.
2. Line of the longitudinal wound along the inner border of the sterno-cleido-mastoid.
3. Reflection of the triangular piece of integument.
4. Deep-seated fascia of the neck, involving the sterno-hyoid and sterno-thyroid muscles, and covering the trachea.
5. Lower end of the scalenus anticus.
6. Internal jugular vein.
7. Graefe's aneurismal needle carried under the arteria innominata.
8. Origin of the subclavian.
9. Vertebral artery, embraced by a thread near its root, and raised up so as to come into view.
10. Inferior thyroid artery.
11. Internal mammary.
12. Transverse cervical artery.

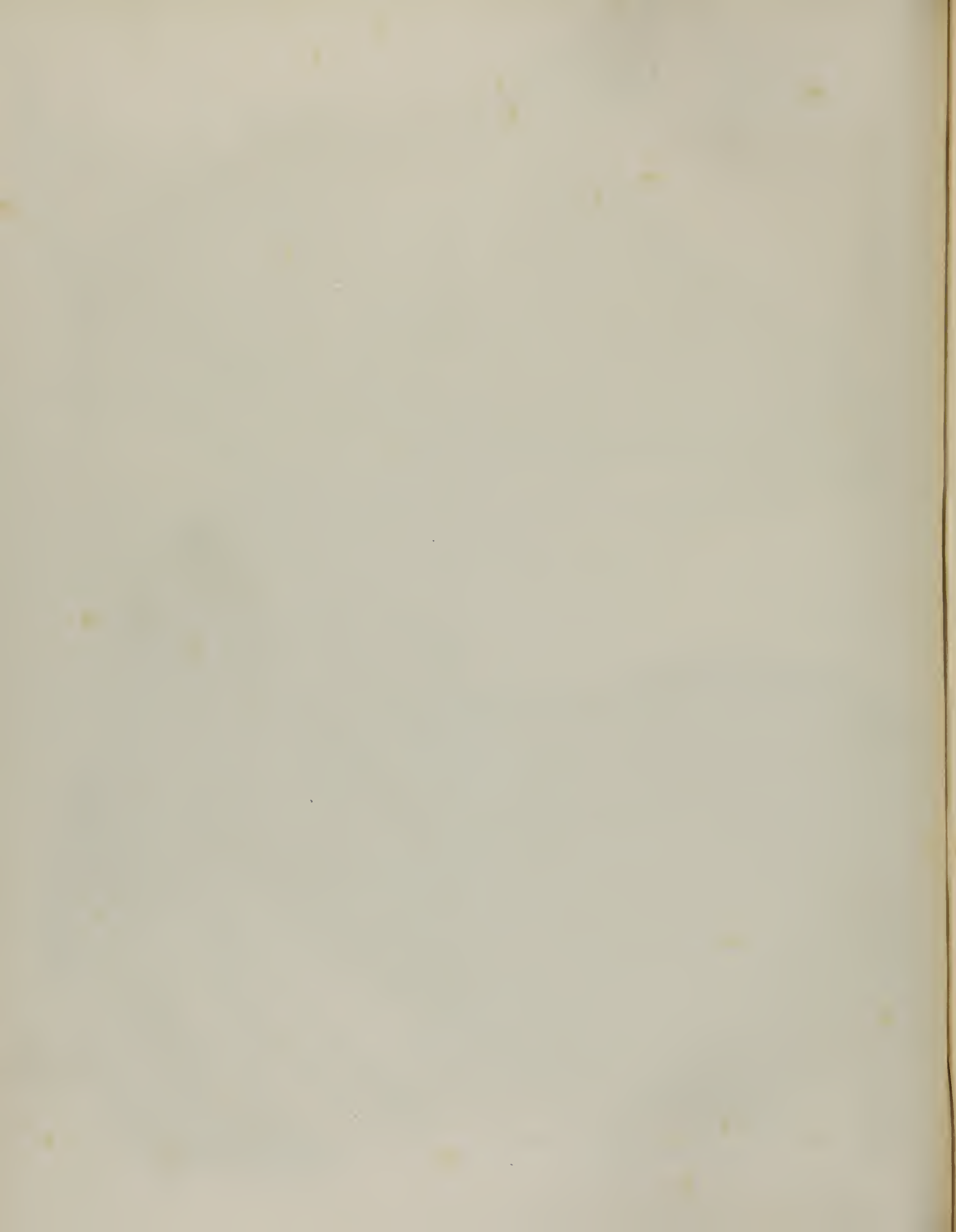
Fig. 2.—Ligature of the subclavian below the clavicle, or more properly speaking, of the axillary under the pectoral muscle. (Process of the author.)

Fig 1



Fig 2





tremity of the thoracic duct, which above the level of the sternum gets into the space between it and the left vertebral artery.

With the exception of their lower end, they have similar relations with surrounding parts. Each is enveloped in a sheath, behind which and separating it from the muscles on the front of the vertebræ, is the trunk of the great sympathetic nerve, and at the lower part of their course the inferior thyroid artery and recurrent laryngeal nerve. The sheath embraces besides the artery the par vagum nerve and the internal jugular vein. The artery lying upon the inner side next the trachea and larynx, the vein without, and the nerve between but somewhat posterior to the two. Delicate processes of the sheath pass between these parts, from behind forwards, so as to keep them asunder; but not so as to prevent the vein from slightly overlapping the artery. Just above the middle part of their course, the omo-hyoid muscle runs obliquely upwards and inwards over the front part of the sheath. Above this point the sheath of the vessels is covered only by the skin, platysma muscle and superficial fascia, and the descendens noni nerve which runs obliquely downwards and forwards. The artery is so superficial, that it may be seen or felt pulsating in a triangular space, bounded without by the anterior part of the sterno-cleido-mastoid, within by the ascending portion of the omo-hyoid, and above by the digastric. At its superficial position here, opposite the larynx, the ordinary operation for ligature of the carotid is performed. Below the omo-hyoid, the artery is more deeply placed. It is covered there, in addition to the parts above men-

tioned, with the sternal portion of the sterno-cleido-mastoid, and the sterno-hyoid and thyroid muscles.

Anomalies.—Anomalies in the course or origin of these vessels are very unusual. They have been referred to in the preceding article.

Anastomosis.—The anastomosing communications between the branches of these arteries and the surrounding vessels, are so numerous, that the circulation is readily re-established after the trunks have been tied. The vertebral, the internal carotid, the thyroid, lingual, facial, temporal, &c., of the two sides, communicate so freely together, that the pulsation in the trunk above the ligature returns in a short space of time. It is for this reason that ligature of the carotid is now so commonly abandoned in the treatment of erectile tumours seated on the branches of that vessel.

Remarks.—The ligature of this vessel is rarely practised now, except for the cure of aneurism of the trunk or some of its branches, or in extensive wounds of the face and neck. In former times, it was much employed as a preparatory measure in resection of the jaws, removal of tumours from the face, and ablation of the parotid gland. But it has been found by experience, that secondary hemorrhage is apt to follow from the return of blood into the divided vessels, and that it is better to secure these as they spring, as the loss of blood may be temporarily checked so as to give time to find the divided branch, by pressure of the lower part of the carotid against the spine, which is sufficiently superficial for that purpose. Both carotids have been obstructed by ligature in the

The patient is inclined upon the left side, with the right shoulder raised as high as the case will admit. An assistant places his thumb above the clavicle so as to make pressure on the main trunk between the scaleni muscles, in case it should be needed by an accidental wound of the vessels. The incision of the integument is made directly over the interstice, which may be felt through the skin separating the sternal from the clavicular portion of the pectoralis major muscle. The upper section consisting of skin and clavicular portion of the muscle, has been divided on the finger or director from within outwards, and in a direction at right angles with the course of the muscular fibres.

- a. Portion of the pectoralis major muscle, which takes its origin from the sternum.
 - b, b. Clavicular portion divided across, and the ends reflected to expose the parts below.
 - c. Posterior fascia of the pectoral muscle, found immediately on its inner face.
 - d. Part of the same fascia, all the intervening portion having been removed.
 - e. Tendon of the pectoralis minor near its insertion on the coracoid process, drawn slightly downwards with a blunt hook.
 - f. Axillary vein at the front and inner side of the artery.
 - g, g. Axillary artery—both these vessels are seen just as they got below the clavicle, where they take the name of subclavian.
 - h. Anterior root of the brachial plexus of nerves, lying behind and to the outer side of the artery. Posterior to this root are seen the other branches of the brachial plexus.
 - i. Cephalic vein of the arm crossing in front of the nerves and the artery, to empty into the axillary vein. Above this, another small vein is seen winding over the artery to reach the axillary vein. A third small venous branch is seen coming up in front of the artery.
 - k. Origin of the external thoracic arteries by a common trunk from the axillary, as was the case in the subject from which this drawing was taken.
 - l. One of the external thoracic nerves.
- A ligature is seen applied about the artery in the upper part of the wound near the clavicular fossa, at the usual place of operation. Another at the lower part of the wound, embraces the artery just above the pectoralis minor and below the cephalic vein. One of the many advantages which attend this process, is the facility of largely uncovering the vessel without much dissection, so as to apply the ligature upon either one of these points as may be desired.

same individual. Professor Mott tied them nearly simultaneously in a case of desperate necessity. The patient died in the course of twenty-four hours, and it is questionable whether the human brain could sustain the sudden deprivation of two such columns of blood as those sent up by the carotids. Where a considerable interval of time has elapsed between the operations for ligature of the two vessels, the result has been more successful. The artery may be tied at two points, either above or below the omo-hyoid muscle.

LIGATURE AT THE PLACE OF ELECTION OR UPPER THIRD OF THE CAROTID. (PL. X.)

Operation.—The patient is placed in the recumbent posture, with his shoulders a little elevated, the face turned to the opposite side and supported by an assistant, and the chin carried back so as to extend the integuments on the front of the neck. An incision is then made on the anterior edge of the sterno-cleido-mastoid, commencing an inch below the angle of the jaw, and extended half-way down the neck. Before commencing the incision, de-

press with the fingers of the left hand, the groove intermediate to the trachea and the edge of the muscle, so as to make the latter more conspicuous. After section of the skin, raise and divide successively on the director the platysma muscle and superficial fascia, taking care to avoid wounding the anterior jugular vein,—a branch usually met with connecting this with the external jugular,—or any of the lower superficial nerves. The deep-seated layer of fascia, connecting the edge of the sterno-cleido-mastoid to the sterno-thyroid and hyoid muscles, is to be divided in like manner on the director. The scalpel is now to be laid down, the chin lowered to its usual position so as to relax the muscles, and the margins of the wound held asunder by blunt hooks or the fingers of an assistant. With the point of the director or forceps, or the end of the left fore finger, break the cellular tissue so as to expose the sheath of the vessels, over which and partly through which will be seen crossing the descendens noni nerve. In some operations on the living subject, I have seen this nerve as large nearly as the par vagum, but easily distinguished from it by its oblique and superficial position. Raise the sheath carefully with the point of the forceps, and open it upon its inner side over

PLATE X.—LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.

OF THE PRIMITIVE CAROTID AND EXTERNAL CAROTID ABOVE THE OMO-HYOIDEUS.

The incision is made along the internal edge of the sterno-cleido-mastoideus and is larger than necessary in operations on the living subject, in order to render the plate more useful, by showing fully the relation of the different parts involved. The head is represented thrown back, and the face a little inclined to the opposite side.

(A). One edge of the divided platysma-myoides.

(B). Anterior margin of the sterno-cleido-mastoid.

(C). Anterior belly of the omo-hyoid, running up to its insertion on the os hyoides.

(D D). Sheath of the vessels, laid open so as to show the primitive and external carotid arteries.

1. External carotid, with a ligature below it, showing that this vessel may be taken up by a slight extension upwards of the ordinary incision for ligature of the common trunk.
2. Primitive carotid. It is raised on the ordinary aneurismal needle, which, previous to being used on the living subject, is to be threaded with the ligature.
3. External jugular vein.
4. Descendens noni nerve, pushed a little out of its course by the needle. The pneumogastric or par vagum nerve lies between the carotid artery and jugular vein, and is not seen in the drawing.

OF THE FACIAL ARTERY.

The incision is made just in front of the masseter, and, for the reason above given, it is made of large size.

(A). Anterior edge of the masseter muscle, exposed by an incision through the skin and the platysma.

1. The facial artery, raised on the needle.
2. The facial vein.
3. Branches of the portio dura nerve.

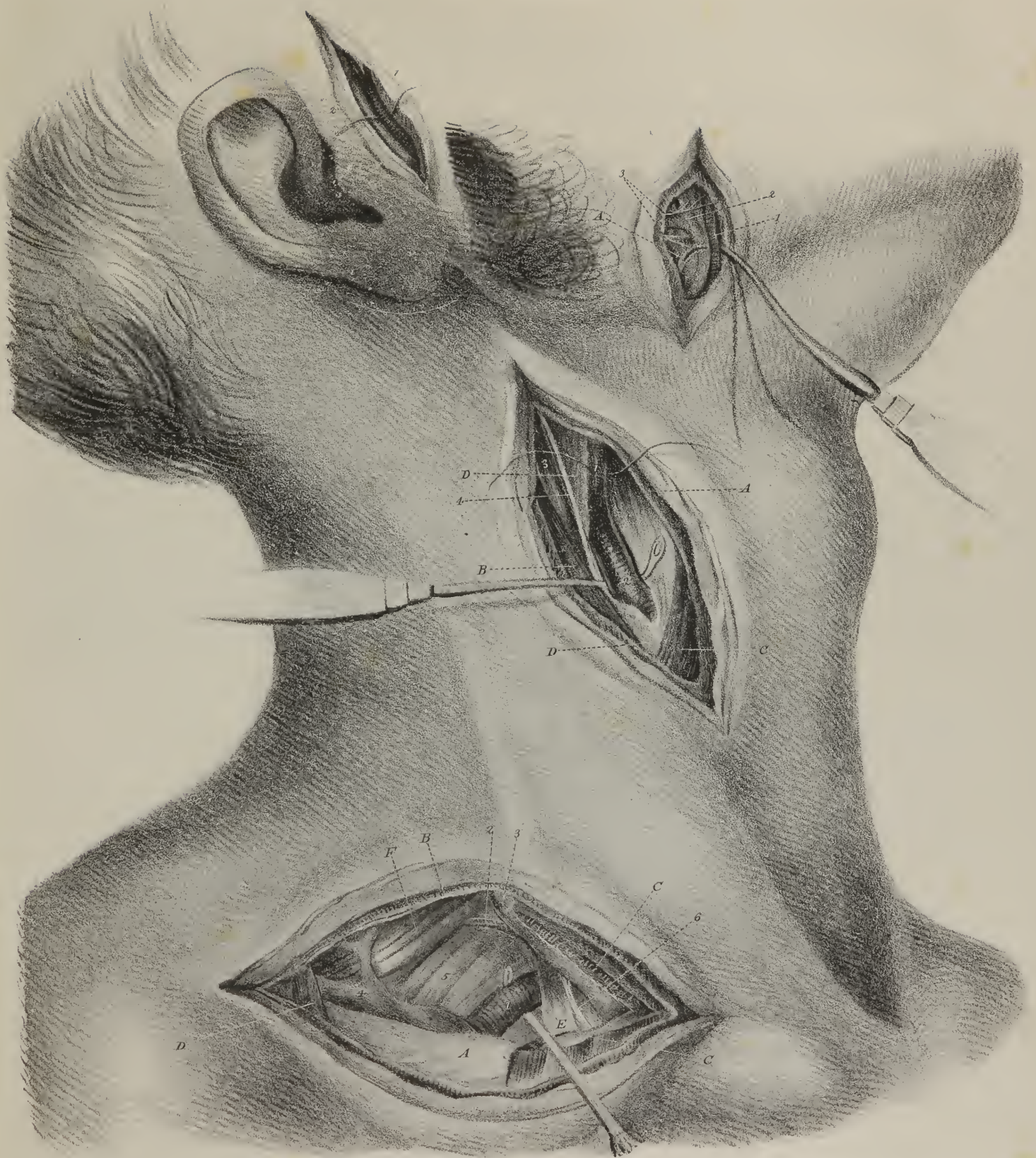
OF THE TEMPORAL ARTERY.

The incision is made just in front of the ear.

1. The temporal artery, which is seen branching at the upper part of the wound. The trunk is raised on a ligature.
2. Temporal vein.

POSTERIOR AURIS.

A curved white line is drawn below the ear, to indicate the place of incision for the posterior auris artery.



the carotid, so as to avoid the nerve, and enlarge the orifice on a director in order to expose the vessel. At the lower part of the wound the middle tendon of the omo-hyoid is seen crossing the sheath. If it be in the way in opening the latter, it may be depressed, or, if necessary, divided. The internal jugular vein is to be held slightly downward and outward; and if it swell up so as to obscure the artery, as is apt to be the case when we operate on a struggling patient, it may be compressed with the finger at the upper angle of the wound. With the point of the director, isolate the artery for a little space first on its outer and then on its inner side. The end of the grooved director, slightly curved, or an aneurismal needle, is to be passed from without inwards behind the vessel, so as to avoid disturbing the par vagum,—placing the index finger of one hand on the inner side of the artery to give it a point of support. The ligature is then to be placed and secured as described at page 41. If the operation be neatly done, the pneumogastric nerve is not brought into view, and provided the rules above detailed are carefully observed, neither the sympathetic nerve behind the sheath, nor the recurrent laryngeal on its inner side, parts of great functional importance, run any risk of being injured.

If the internal jugular vein should by accident be *punctured*, a casualty which has sometimes happened, it is to be seized at once with the thumb and finger; a couple of fine pins are then to be passed through the edges and across the orifice, and a delicate silk ligature tied below so as to embrace the opening; the pins may then be withdrawn. If the opening be of much size, the vein should be tied both above and below the orifice. In a case of extensive wound, Mr. Simmons, of Manchester, tied the main trunk of the vein, and was so fortunate as not to lose his patient. In wounds of this vein, it might be possible even to save the patient by plugging and compression, as was the case with an

ancestor of the distinguished Mirabeau. But it is an accident which ought not to occur in an operation like this, which is one of no great difficulty.

LIGATURE OF THE COMMON CAROTID AT ITS LOWER PART. PLACE OF NECESSITY. (PL. XI.)

Circumstances that would render this operation necessary, as the existence of an aneurism of the carotid occupying a considerable part of the side of the neck, must, of course, from the additional embarrassment presented, make it one of considerable difficulty. It has, however, several times been successfully performed on the living subject, under such embarrassments. The difficulty encountered is in laying bare the root of the carotid, between the tumour and the sternum. The method, therefore, which shall best expose the parts to the eye, is the one to which preference should be given. The difficulties here are much the same as in ligature of the innominata, and for reasons given when treating of that operation, the plan of Mott, somewhat modified as to the length of the incisions, as it has been by Coates, will in the author's opinion be found most appropriate. An incision of three inches in extent is to be made along the inner margin of the sterno-cleido-mastoid, terminating at the top of the sternum; an inch from the top of the sternum another incision parting from this is made parallel with the direction of the clavicle, ending just beyond the sterno-clavicular articulation. The sternal portion of the muscle is to be divided in the latter direction, and turned upwards. The remaining steps of the operation for the isolation of the carotid is nearly the same as that detailed in the operation of Mott, p. 43.

When the aneurism of the carotid is small and placed near its bifurcation, the vessel may be readily uncovered and tied for

OF THE SUBCLAVIAN ABOVE THE CLAVICLE.

A large transverse incision is made just above the clavicle, and the two lips of the incision are pushed in opposite directions to enlarge the surface of the wound. The sterno-cleido-mastoid is in part divided near its origin, for the purpose of exhibiting the parts below more distinctly in the drawing.

- (A). Clavicle, bared by the depression of the inferior lip of the wound.
- (B). Platysma-myoides, divided in the whole length of the cutaneous incision, and seen on both the lower and upper lips of the wound.
- (C C). Clavicular portion of the sterno-cleido-mastoid divided.
- (D). Anterior edge of the trapezius at its insertion on the clavicle.
- (E). Scalenus anticus, seen at its insertion on the first rib.
- (F). Commencement of the anterior belly of the omo-hyoideus from its middle tendon.
 1. Subclavian artery raised on the aneurismal needle at the place for applying the ligature.
 2. Transversalis colli, or posterior scapular artery. Very commonly we find here another artery with which it is important the operator should be familiar, called the supra-scapular, that comes off either from the subclavian directly, or, which is more usual, from the thyroid axis, crosses the cellular space in which the subclavian is lodged, and skirts the inner and upper margin of the clavicle, being connected to the subclavius muscle by some cellular tissue. When the artery has this position, it is liable to be wounded in the operation on the subclavian, unless care is observed. In the subject from which the plate was taken, the supra-scapular artery was a branch of the axillary.
 3. Internal jugular vein, emptying into the subclavian vein near the junction of the latter with the internal jugular.
 4. Vein corresponding to the branches of the supra-scapular artery.
 5. Brachial plexus of nerves, lying on the outer and posterior side of the artery.
 6. Phrenic nerve, passing to the inner side of the insertion of the scalenus anticus muscle.

some distance below the omo-hyoid, by an incision along the anterior surface of the sterno-cleido-mastoid muscle, as shown at Pl. XI. following the same rules as for the operation above the omo-hyoid. Great care is required to avoid wounding a vein of considerable size, which is usually found descending behind the inner border of the lower third of the sterno-cleido-mastoid.

Process of Sedillot and Zang.—If it should ever become necessary to tie the carotid at its lowest point in the neck, when the relation of the parts is not disturbed or marked by the presence of a tumour or effused blood, it may readily be done in the following manner. The head being thrown back and to the opposite side in order to make the sterno-cleido-mastoid tense, an incision two and a half inches long is to be made in the direction of the fissure between the sternal and clavicular portions of this muscle. The cellular interval between them is to be carefully opened; the head is now to be inclined towards the side of the operation, and the two portions of the muscle thus relaxed, held asunder with blunt hooks. The sheath of the vessel is next to be exposed at the bottom of the wound, and carefully opened with the point of the director. In the attempt to do this, the internal jugular vein first comes into view. This vessel is to be drawn outward and backward, and the artery will be found on its inner side, lying in front of the pneumogastric nerve, and is to be raised from without inwards with the curved aneurismal needle or bent director. In the operation on the left carotid low in the neck, it is to be recollected that the artery, in consequence of its origin from the descending turn of the aorta, is deeply placed. From this cause, and the presence of the thoracic duct behind it, it will be found one of greater difficulty and delicacy than on the right side. The operation terminated and the wound dressed, the patient is to be placed in bed with his head elevated so as to keep the artery in a relaxed position.

LIGATURE OF THE EXTERNAL CAROTID. (PL. X.)

Surgical anatomy.—The primitive or common carotid divides, as has been before observed, into its two branches, external and internal, nearly on a line with the upper border of the thyroid cartilage. But in females it is well to remember that, in consequence of the greater proportionate length of the neck, the division usually takes place lower—nearly opposite the middle of the cartilage. The external is found at its origin, a little in front and to the inner side of the internal carotid, and it, as well as the internal, is readily found by tracing up the course of the common carotid. Both are sufficiently superficial to be tied, if necessary, on the living subject. The course of the internal is short, before it enters the carotid canal of the temporal bone to supply the brain; it has never been the subject of operation. The external carotid is covered in front only by the integuments, the platysma-myoid muscle, and the superficial cervical fascia. It is crossed in front, shortly after its origin, by the posterior belly of the digastric muscle and the hypoglossal nerve, and is lodged in a groove, the walls of which are formed by the pharynx and os hyoides on its inner side, and the internal edge of the sterno-cleido-mastoid without, and the submaxillary and parotid glands above. In this region it sends off its various branches, the superior thyroid, lingual, facial, occipital, and posterior auris. The continuous trunk passes up

deeply through the substance of the parotid gland, and divides in the space between the neck of the lower jaw and the external auditory meatus, into the temporal and internal maxillary.

Remarks.—It is only in its cervical portion that the artery can be cut down upon and tied. It is most superficial and accessible below the digastric. The extension upwards for near an inch higher than usual of the ordinary incision for the common carotid, serves, as shown in Pl. X., for the exposure of the lower part of its external branch. Above this point the difficulty of the operation is much increased, from the number of important parts which surround the vessel. It has been several times tied, and the patients have recovered without secondary hemorrhage, a result which is always to be dreaded when a large artery is secured near the place of its ramifications, even though they be on the distal side of the ligature; for it has been shown by Mr. Porter, that this serious accident may arise from blood returned by large anastomosing trunks into the vessels beyond the place of its obstruction. It has been tied for wound or aneurismal enlargement of its branches; and as a preparatory step against hemorrhage—in operations for the resection of the jaws and parts of the tongue, for tumours of the antrum, and the removal of the parotid gland. But it is questionable, as before observed, whether, in consequence of its numerous anastomoses, this artery should ever be tied except in cases of wound where its cut extremities are exposed; and it is considered better, in hemorrhage from operations on the face, not to be checked by ligature of the divided vessel or the use of the actual cautery, but to proceed to the simpler and safer process of tying the common carotid.

Usual operation.—To tie the *external carotid*, an incision should be commenced half an inch below the angle of the jaw, and extended as low as the middle of the thyroid cartilage, parallel with but half an inch in front of the edge of the sterno-cleido-mastoid muscle. The platysma-myoides and cervical fascia being divided on a director, and the sheaths of the submaxillary and parotid glands loosened from their attachment below, the glands themselves are to be pushed upwards and forwards. The digastric and stylo-hyoid muscles are now to be laid bare at the bottom of the wound with the point of the director or forceps. The muscles are to be drawn upwards and forwards with a blunt hook. The sheath of the vessel is now exposed, crossed in front by the hypoglossal nerve and the facial vein. The sides of the incision are to be held widely separated, the nerve and the vein are to be carried backwards with the end of the finger, the sheath of the vessel cautiously opened, and the artery, which is seen pulsating by the side of the pharynx, separated and raised with the aneurismal needle.

LIGATURE OF THE SUPERIOR THYROID.

Surgical anatomy.—This is the first branch given off by the external carotid; it arises a little above the place of bifurcation of the primitive trunk. Passing first upwards and forwards to the corner of the os hyoides, it then turns downwards, forming an arch convex towards the chin, to reach the upper part of the thyroid gland and the larynx. As it passes upwards and inwards it is superficial—covered only by the integuments, platysma-myoides, and superficial fascia. In the lower part of its course it gets be-

neath the omo-hyoid, sterno-hyoid and thyroid muscles. The hypoglossal nerve is placed above, and the superior laryngeal a little distance behind it.

Remarks.—This artery, in consequence of its anterior position, is frequently divided in abortive attempts to commit suicide. If in the gaping wound which is left, the two orifices of the divided vessel can be discovered, they are to be seized and tied; but from the effusion of blood in the surrounding cellular tissue, and the heaving motion of the parts in respiration, which is always more or less laborious, I have found it in some cases difficult to discover them, and especially the one on the side next the origin of the vessel. Under such circumstances, I have been obliged to have recourse to ligature of the primitive carotid. Walther, Theden, Langenbeck and others, have tied the superior and inferior thyroid artery of each side, in the hope of diminishing by atrophy the size of the thyroid gland in goitre. These vessels have also been tied by surgeons who have deemed it prudent to attempt the extirpation of this gland, for the same species of enlargement. The process by which the superior thyroid is tied, varies but little from that for the ligature of the facial, to which the reader is referred.

OF THE LINGUAL ARTERY. (PL. XI.)

Surgical anatomy.—The lingual artery is given off a little above the last named, above which it forms a small arch, convex towards the ramus of the jaw. It is found near its origin on the outer surface of the middle constrictor muscle of the pharynx, and runs upwards for half an inch, almost in contact with, and obliquely across the extremity of, the great cornu of the os hyoides, to get beneath the hyo-glossus muscle. In the *second part* of its course, the artery continues ascending obliquely forwards and upwards, but much curved for the distance of an inch, when it turns, vertically, into the substance of the tongue, giving off its raninal and sublingual branches. In the *first part* of its course, from its origin to the hyo-glossus, it is at first merely covered by the integuments, platysma, fascia, and a few small veins; but it is crossed near the cornu by the tendon of the digastric, the stylo-hyoid muscle, and the ninth nerve, which, placed below it in the neck, ascends so as to cross it at this point. In the second part of its course it is covered by the hyo-glossus and mylo-hyoid muscles, and is separated by the former muscle from the ninth nerve, which is *here* placed higher up than the artery, but again gets lower than the vessel at the anterior border of the hyo-glossus muscle. At the end of its second course the vessel is found three-quarters of an inch above the body of the os hyoides. The glosso-pharyngeal nerve is placed above the artery, so as to be out of the way in the operation.

Anomalies.—The artery, instead of coming off as a separate trunk from the carotid, may have a common origin with the facial or the superior thyroid, or the three may arise together by a single root.

Remarks.—The ligature of this vessel on the living subject is by no means easy, and requires a thorough knowledge, on the part of the operator, of the structures concerned. The vessel is invariably found deeper than the description of its position, or its appearance after the superficial parts are cut away would lead one to suppose; the prominence of the os hyoides and larynx on one

side, and the position of the sterno-cleido-mastoideus on the other, keeping the skin, platysma, and superficial fascia stretched between them, at some distance in front of the vessel. This operation has been but little practised. It was proposed by Beclard as a precautional measure, in wounds or extensive operations on one side of the base of the tongue, where the artery is found so large, that there is reason to fear, that the eschar produced by the actual cautery, the usual means of arresting hemorrhage in operations on this organ, would not be sufficient to check it. It has been tied by Amussat and Mirault on the living subject, with the view of arresting the progress of cancer of the tongue, a project presenting little prospect of success.

Operation. (Process of the author.)—The patient is placed as for the ligature of the carotid. The operator ascertains with the finger, as a fixed point of guidance in the operation, the exact position of the body and great cornu of the os hyoides. An incision of about two inches in length is to be made carefully through the skin, beginning it about three-eighths of an inch above the junction of the cornu and body of the os hyoides at a point equidistant from the ramus of the jaw and the chin, and extended outwards to the inner margin of the sterno-cleido-mastoid. The incision should be directed slightly downwards, so as to pass above the extremity of the cornu of the os hyoides. The superficial fascia and platysma muscle are next to be opened at the inner border of the wound, and divided for the same extent in the previous direction. The submaxillary gland covered by its capsule is now exposed to view. The cellular tissue below it is to be ruptured with the point of the director, and the gland drawn upwards on the blunt hook. The facial vein, which is observed passing across toward the external jugular, is to be drawn to the back part of the wound. The shining tendon of the digastric muscle is now seen crossed above by that of the stylo-glossus. The anterior belly of the digastricus, immediately adjoining this tendon, is to be denuded and slightly raised with the point of a director. Immediately below it is seen the hypoglossal or ninth nerve, and one line below this nerve the artery may be felt pulsating under the hyo-glossus muscle. The fibres of this muscle are to be cut on the director, and the artery is found, unaccompanied with either vein or nerve, and may be readily raised and tied.

The artery may likewise be laid bare, posterior to the stylo-hyoid, over the extremity of the cornu. For this purpose, the posterior belly of the digastricus is to be drawn downwards. The hypoglossal nerve then comes into view below this nerve, and a little deeper lies the artery, which may be secured and tied at a point not far from its origin. Several processes have been detailed for the ligature of this vessel; but the one given above appears to me preferable, as it is attended with greater certainty of finding the vessel, less embarrassment from the surrounding parts, and admits of at least equal celerity in its performance.

OF THE FACIAL ARTERY. (PL. XI.)

Surgical anatomy.—This artery usually arises from the external carotid just above the lingual, but sometimes by a common trunk with the latter. It mounts over a groove in the lower jaw, at the

anterior border of the masseter muscle, where it may be felt pulsating. It supplies the lips, *alae nasi*, and adjoining portion of the face. The best place for tying it is at the edge of the masseter after it has turned over the bone. It is somewhat deeply placed in consequence of the thickness of the masseter, and is covered by the integuments, *platysma myoides*, and a layer of dense yellowish cellular tissue. The facial vein is at its posterior or temporal side, and it is crossed by some branches of the facial nerve.

Remarks.—This vessel may be readily compressed under the jaw, as has been before observed, (page 32,) with a graduated compress and bandage, or the pad of *Charrière*; though if the pressure be protracted it becomes too painful to be borne. Temporary compression with the finger is more often employed, in

order to diminish the hemorrhage, in plastic or other operations about the face. Its trunk has been many times tied in front of the masseter for the same object, but unnecessarily, as the position of its branches is superficial, and may readily be secured during an operation; the communication between the branches of the two sides is so direct, that it sometimes becomes necessary to twist or tie both orifices of each divided branch.

Operation.—An incision through the skin and *platysma* an inch and a quarter long, is to be made across the jaw bone at the anterior edge of the masseter, which, with the artery, may be readily felt at this point. The cellular tissue covering the vessel is to be opened on the director, avoiding the branches of the *portio dura*. The artery will be found immediately below.

PLATE XI.—LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.

LIGATURE OF THE PRIMITIVE CAROTID BELOW THE OMO-HYOID MUSCLE.

The artery is here more deeply placed and more difficult of access, than it is above the omo-hyoid.

- (A). *Platysma-myoides* divided with the skin and superficial cervical fascia.
- (B). Sterno-cleido-mastoid drawn to the outer side of the wound.
- (C, D). Sterno-thyroid and sterno-hyoid, drawn in the opposite direction.
- (E). Anterior belly of the omo-hyoid.
- (F). Portion of the sheath of the vessels laid open over the carotid.
 1. Primitive carotid.
 2. Internal jugular vein.
 3. Anterior jugular vein, usually found on the inner edge of the sterno-cleido-mastoid.
 4. *Descendens noni* nerve, drawn to the tracheal side of the wound.

LIGATURE OF THE LINGUAL ARTERY.

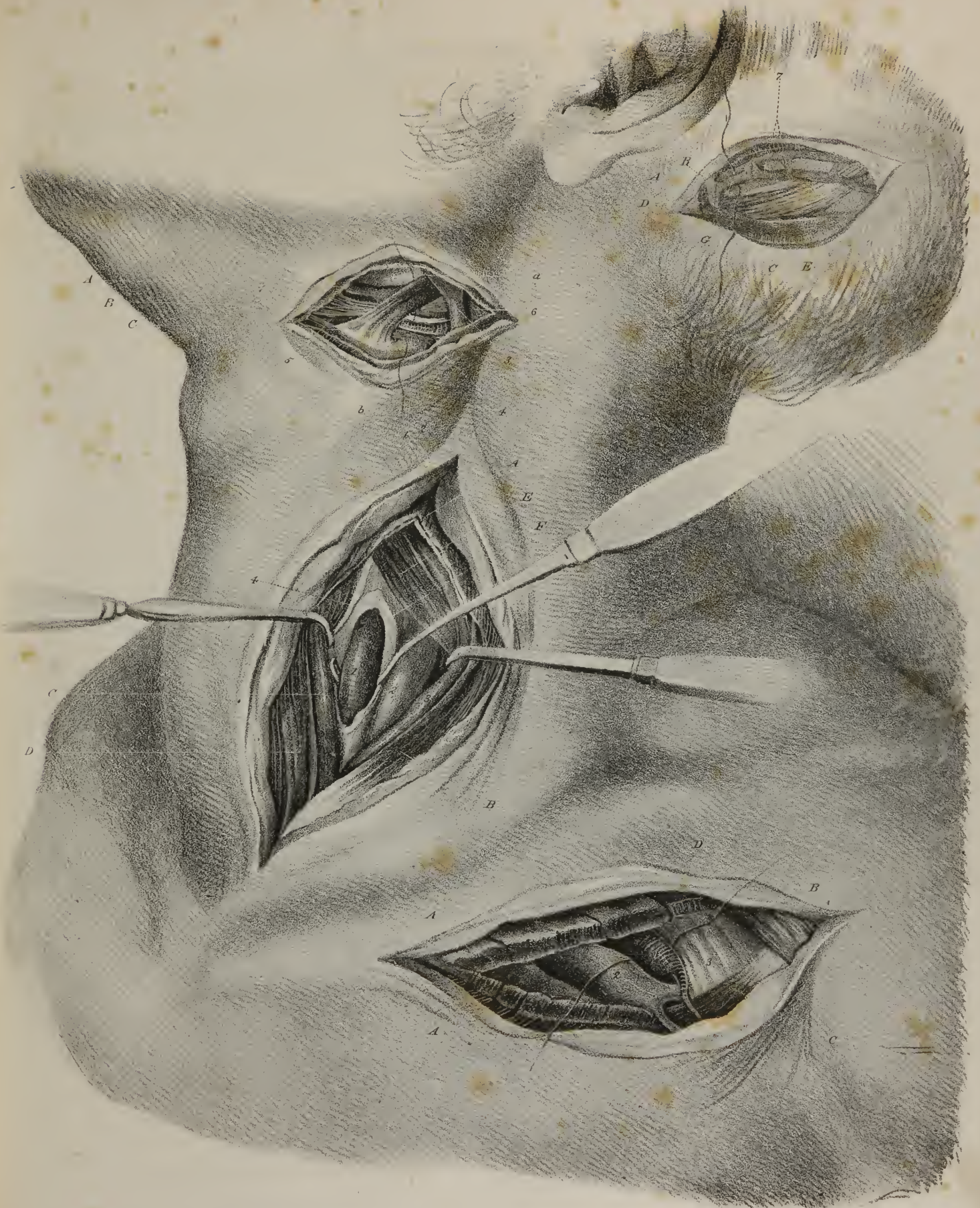
The incision is made a little below the base of the jaw, from the *os hyoides* to the sterno-cleido-mastoid muscle.

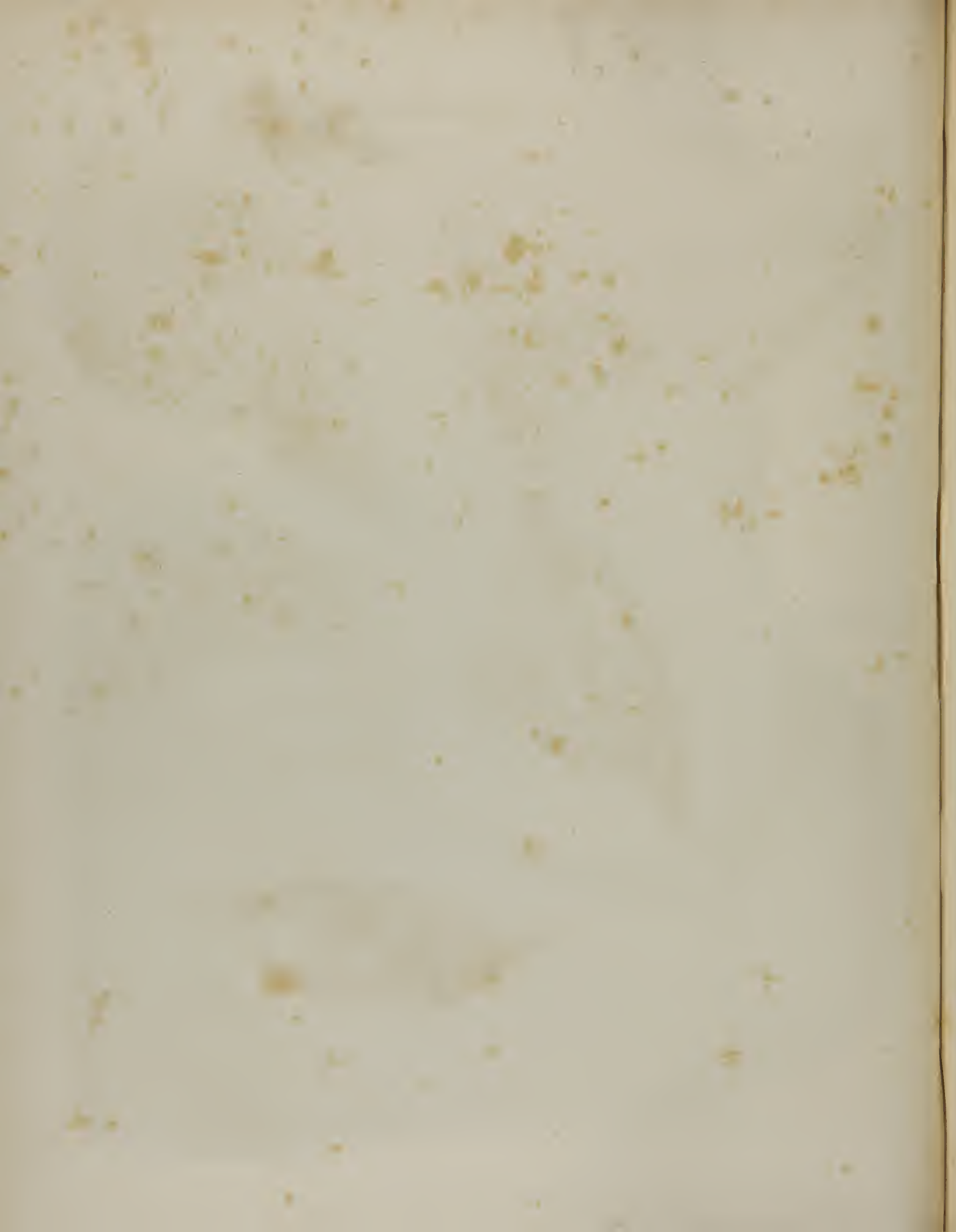
- (A). *Platysma-myoides* divided with the integument.
- (B). Anterior belly of the digastric muscle, after its middle tendon has pierced the stylo-hyoid.
- (C). Stylo-hyoid muscle, inserted on the *os hyoides*.
 - a. Inferior edge of the submaxillary gland.
 - b. Greater cornu of the *os hyoides*.
 1. Lingual artery raised on the ligature thread.
 2. Hypoglossal or ninth nerve.
 3. Facial vein, running down to form the anterior jugular.
 4. *Hyo-glossus* muscle. The fibres are divided to expose the lingual artery, which, in this part of its course, is found below the muscle.
 5. Posterior part of the mylo-hyoid muscle.
 6. External carotid, raised to show its position.
 7. Anterior edge of the sterno-cleido-mastoid.

LIGATURE OF THE OCCIPITAL ARTERY.

The incision is made from just behind the point of the mastoid process obliquely upwards and backwards.

- (A). Position of the mastoid process.
- (B). Tendinous expansion of the sterno-cleido-mastoid muscle.
- (C). *Splenius capitis* muscle divided.
- (D). Posterior border of the trachelo-mastoideus muscle.
- (E). Superior oblique muscle.
- (G). Occipital artery, raised on a ligature.
 7. The two occipital veins, which are seen sending branches of communication over the artery.





OCCIPITAL ARTERY.

Surgical anatomy.—It arises from the posterior part of the external carotid, nearly opposite the facial, and at the lower border of the digastric muscle. It runs obliquely upwards and backwards to the inner surface of the mastoid process of the temporal bone, where it is covered by all the muscles that are inserted into the mastoid process. From this part it runs rather horizontally backward, parallel to, but above, the inferior ridge of the occipital bone, lodged between the splenius and the complexus and superior oblique muscles; after which it turns upwards to be distributed over the posterior part of the cranium. It is in its middle or horizontal portion only that it can readily be taken up, between the insertion of the sterno-cleido-mastoideus and the trapezius. At this point it is surrounded by two veins closely united to it by dense cellular tissue, covered by the splenius, the aponeurosis of the sterno-cleido-mastoid which is attached to the superior ridge of the bone, and the thick integument.

Remarks.—The ligature of this vessel has not yet, I believe, been made upon the living subject. The position of the artery is such that in cases of wounds involving it, it may either be secured at the place of injury or compressed against the bone. Circumstances, however, may possibly arise,—such as aneurism, or a tendency to erysipelas presenting an obstacle to compression,—that may render its ligature necessary. A wound of the vessel near its origin, in consequence of the depth at which it is placed, and the difficulty of ascertaining precisely the trunk from which the hemorrhage arises, must be met by ligature of the external or rather of the primitive carotid.

Operation.—The scalp having been shaved behind the ear, an incision is made through the skin an inch and a half to two inches long, beginning it at the posterior border of the sterno-cleido-mastoid, about half inch behind and a little below the point of the mastoid process, and carrying it obliquely backward and upward in the direction of the superior curved line of the occipital bone. The aponeurosis of the above muscle is next divided, and the splenius exposed just below the line of its insertion. The splenius is next to be divided the whole length of the wound, either by incision from above downwards with the knife, or on the groove of the director. The artery, which may now be felt pulsating, is to be isolated and tied. M. Manec has observed that particular care should be taken not to open either of the accompanying veins, as from their connection with the lateral sinuses of the brain through the mastoid foramen, they might bleed very freely.

POSTERIOR AURIS.

Surgical anatomy.—The posterior auris, or stylo-mastoid artery, arises from the external carotid just above the digastric muscle. It escapes from under the parotid gland, on a level with the mastoid process, and runs obliquely backward and upward towards the roots of the hair on the occiput. It crosses the styloid process in the neck, and sends a branch in at the stylo-mastoid foramen. It has passing in front of it near the same point, the portio dura nerve. More posteriorly, it is found crossing the surface of the mastoid process, in the interval between this protuberance and the concha of the ear, and about a quarter of an inch below the latter. It is here covered with a dense subcutaneous cellular layer, through which the artery may be indistinctly felt pulsating, and is attended by the posterior auricular branch of the facial nerve, and usually one or two filaments from the auricularis magnus of the neck.

Remarks.—In former times it was the custom to bleed from this artery by opening it in front of the mastoid process; and though the practice has been abandoned by all reputable practitioners, it is still resorted to occasionally by empirics in certain portions of this country. The nerves which attend this vessel render compression after arteriotomy painful, and false aneurism sometimes follows as a consequence of the operation. I tied the vessel, according to the following process, for a tumour of this description occurring in the case of a gentleman who had been his own bleeder, and which, after it had attained the size of a small walnut, burst and flooded him with blood.

Operation.—An incision is to be made from an inch to an inch and a half long, somewhat obliquely across the course of the vessel. It should be begun near the lower point of the mastoid process, on a level with the lower end of the lobe of the ear, and carried obliquely downwards in the direction of a point half-way between the lobe and the angle of the jaw. In dividing the superficial fascia,—which, on account of the density of the tissues of the part, has usually to be done without a director,—two branches of the great auricular nerve will be observed passing upwards and backwards. Between these, though somewhat deeper, lies the artery, which may be tied either after or before it has given off the auricular branch. The line for the cutaneous incision is shown in Plate 10.

TEMPORAL ARTERY. (PL. X.)

We have already, in treating of arteriotomy, (page 19,) spoken

LIGATURE OF THE SUBCLAVIAN BELOW THE CLAVICLE, SOMETIMES CALLED THE HIGH OPERATION ON THE AXILLARY.

The incision is made a little below and nearly parallel with the clavicle. From the depth at which the vessel is placed, and its intimate connection with the vein and nerves, this, which is the ordinary process for ligature of the artery below the clavicle, is perhaps one of the most difficult of any required for the treatment of aneurism.

(A A). Portion of the pectoralis major, cut through after the section of the skin and platysma.

(B). Anterior edge of the deltoid muscle.

(C C). Pectoralis minor muscle, coming up from under the pectoralis major to attach itself to the coracoid process.

(D). Lower edge of the clavicle, occupied by a few of the divided fibres of the pectoralis major.

1. Subclavian artery, raised on the ligature.

2. Subclavian vein, a little in front and to the inner side of the artery.

3. Plexus of nerves, behind and to the outer side of the artery.

of the points at which may be laid bare for the purpose of bleeding, the trunk and anterior branch of this vessel. The ligature of this artery is sometimes required in consequence of aneurism formed either spontaneously, or as the result of a wound. It is in general considered most advisable in such cases, to open the tumour by an incision and turn out the clot, and secure the vessel above and below the place of enlargement after the old method. The author has, however, succeeded perfectly, in several instances, by an operation of much less severity, and which leaves a less deforming cicatrix,—that of cutting down upon and tying the vessel on the cardiac side of the tumour. The tumour afterwards disappears by absorption, accelerated by the use of cold evaporating lotions and compression with a roller bandage.

An aneurismal tumour formed on the middle meningeal artery may, after it has produced an absorption of the walls of the cranium, project without, and be mistaken, if proper caution be not observed in the diagnosis, for one of the temporal artery. A swelling formed in this manner below the temporal muscle, in which no pulsation was noticed, has been mistaken for one of the common cystic tumours of the scalp, and the attempt at its removal followed by death.*

LIGATURE OF THE ARTERIES OF THE UPPER EXTREMITY.

OF THE SUBCLAVIAN.

Surgical anatomy.—The subclavian artery of the right side arises from the arteria innominata, at its termination behind the sterno-clavicular articulation. That of the left side comes off directly from the arch of the aorta, and is at first nearly vertical in its course. The right is consequently shorter than the left, and situated on a plane more superficial, as far as the inner edge of the scaleni muscles. After either vessel has passed below the clavicle, it takes the name of axillary. The artery in its course is divided in reference to its surgical relations into three portions. 1st. That between its origin and the scaleni muscles. 2d. That between the scaleni muscles. 3d. That which crosses obliquely over the first rib. The arteries of the two sides vary so much in regard to their direction and surgical relations, as to require a separate description.

First portion.—On the *left side* it passes nearly vertically, having but a slight inclination externally till it reaches the level of the top of the lung. At this point it suddenly turns horizontally outwards to get at once between the scaleni muscles. The point at which it turns is on a level with the upper surface of the clavicle. The artery is covered by the pleura in front, where this membrane passes off to form the posterior mediastinum; the par vagum passes down on its inner side and nearly parallel with it. It lies at first on the trachea and recurrent nerve, then on the œsophagus which projects to the left of the trachea, then on the thoracic duct which crosses beneath to get between it and the carotid; it is next situated on the body of the first dorsal vertebra, and rests at the place of its turn on the last cervical ganglion of the sympathetic, at the upper margin of the first rib. The left

vena innominata crosses in front of it, behind the upper bone of the sternum. The *right subclavian*, from the place of its *origin*, is directed obliquely outwards and upwards; and instead of forming a right angle at the place of its entry between the scaleni, it reaches it by an arch which is convex upwards. It lies in *front* of the pleura, with which it only comes immediately in contact at the margin of the scalenus. Anterior to it lie the muscles of the sternum, the junction of the internal jugular and subclavian veins, the par vagum and phrenic nerves, the latter of which crosses it obliquely from without inwards just at the margin of the scalenus. Over all these parts lies in addition the clavicular portion of the sterno-cleido-mastoid muscle. Behind, it is crossed by the recurrent nerve. The five branches supplied by the subclavian are given off at irregular intervals during the first portion of its course, and near the internal margin of the scalenus.

In the *second and third* portions of their course, the subclavian arteries of the two sides have nearly similar relations.

The *second portion* has a length equal only to the breadth of the anterior scalenus, (the insertion of which covers it in front,) and terminates at the external margin of the first rib. The external surface of the right subclavian alone touches the rib. The left subclavian closely embraces it, so that the latter is even here more deeply placed than the right.

The *third or last portion* of the artery extends from the outer border of the scalenus obliquely downwards and outwards in the direction of the axilla, to the lower border of the first rib, where it takes the name of axillary, as before observed. The curve which it thus describes, rests in a superficial groove on the upper surface of the rib. The point where the artery *first touches the rib*, is, in a well-formed adult with a clavicle of near six inches in length, about two inches and a half from the sterno-clavicular articulation, and a quarter of an inch to the outer side of the internal third of the clavicle. The point where it *leaves the lower margin* of the rib, is three inches and three-eighths from the same articulation, near the outer termination of the middle third of the clavicle; so that the oblique course of this portion of the artery may be considered as lodged under the middle third of the clavicle, when the shoulders remain in their natural square position. The artery is found always, immediately at the outer side of the *tubercle* upon the first rib, on which is inserted the anterior scalenus muscle; on the outer side it is bounded by the brachial plexus of nerves, the large cords of which run down over the rib, parallel, and nearly of equal size, with the artery, so that they resemble somewhat the four fingers of the hand laid over a surface convex and sloping backward, of which the first one is represented by the vessel. By this arrangement, the artery is placed about a quarter of an inch more in front, and a quarter of an inch more within than the front cord of the brachial plexus; a fact which it is important for the operator to bear in mind, as he may thereby avoid the risk of tying a branch of the plexus instead of the artery,—an accident which has been known to occur.

Below and anterior to the artery, runs the subclavian vein, separated from it by the scalenus anticus muscle. At the outer side of the muscle the vein is closely in contact with the artery, and receives there the external jugular, supra-scapular, and sometimes the anterior jugular and acromial veins. Between the vein and the clavicle lies the subclavius muscle.

* Aneurism, Dict. de Med. et de Chir. Prat.

The position of this third portion of the subclavian is superficial, when the clavicle is depressed, as it is lodged in a fossa above the middle part of that bone into which the fingers can be readily sunk, called the supra-clavicular triangle. The sides of this triangle are formed by the clavicle below, by the anterior margin of the scalenus behind, and in front by the posterior margin of the sterno-cleido-mastoid. Covering the vessel at the base of this triangle just above the clavicle, we have 1st, the integuments; 2d, the superficial fascia and platysma muscle—between the layers of this fascia passes downwards and obliquely inwards the external jugular vein; 3d, a layer of cellular tissue surrounding a chain of lymphatic glands; 4th, the superior scapular artery, which passes across the space in a second fascia just above the clavicle, and the transverse cervical which is found a little higher up: below these we find the artery and brachial plexus, lodged in a smaller triangle called the omo-clavicular, formed by the posterior belly of the omo-hyoid, the clavicle and sterno-cleido-mastoid. The depth below the skin at which this superficial portion of the vessel is *usually* found, is about an inch. But this distance may be greatly increased by the presence of a tumour which has displaced the clavicle, or by an enlargement of the chain of lymphatic glands.

Anomalies, in regard to this vessel, are very rare. The vein and the artery have been known to change positions, and Manec has found both in front of the scalenus. The omo-hyoid muscle sometimes has an anomalous insertion by its middle tendon upon the clavicle; and in certain cases, still more rare, is attached to it by the intervention of a small muscle, called the supra-clavicular.

Anastomosing vessels.—If the artery be tied on the inner side of the scaleni muscles, and within the origin of the five large branches it gives off, the restoration of the circulation to the upper extremity can only take place by the same branches that perform this office after ligature of the trunk of the arteria innominata. But if the artery be tied on the outside of the scaleni, the blood will be restored to the limb chiefly by the anastomosis of the internal mammary, the posterior cervical, and the supra-scapular,—with the thoracics, the common scapular, and the circumflex, which are connected with the great axillary trunk.

Remarks.—Compression of this artery, which it is often desirable to make in the diagnosis of axillary tumours and in operations upon the shoulder and breast, can only be efficiently established at the point where the vessel crosses the rib, and when the shoulder is depressed. It is, however, exceedingly difficult, by the ordinary measures, to check completely the circulation for any length of time; the involuntary elevation of the clavicle having a tendency to carry away from the vessel the compressing force. And it is yet to be seen, whether the lately devised and complicated instrument of Bourgery (pl. vii.) will prove an effectual means of producing permanent compression.

The artery has been tied, in cases of wound or axillary aneurism, in each of its three portions. The operation has been done in all between fifty and sixty times, but the result appears to have been more unfavourable than the ligature of any of the other great vessels, with the exception of the arteria innominata and the aorta; death having followed in about one-half the number of cases, the consequence apparently of the great size of the vessel; its proximity to the heart; the dimension and number of the branches it gives off; its unhealthy condition when the operation has been

performed for spontaneous aneurism of the axilla; or of a singular tendency in this variety of aneurism to suppurate after ligature of the main trunk, and form a communication, either with the cavity of the pleura, or with the branches of the bronchia where the lung had been rendered adherent by inflammation to the walls of the chest. After the operation the circulation is generally re-established with great rapidity in the upper extremity. It returned at the end of forty-eight hours in a patient of M. Roux. Though gangrene is little to be feared, serious disturbances of the lungs, heart, and brain, may occur in consequence of the sudden change produced in the movement of the circulating fluid. In the several instances reported of ligature of the trunk on the inner side of the scaleni muscles, the result has been always unsuccessful, and it is a serious question whether it should again be attempted. On the left side it has been but once tied* in this first portion of the vessel, and the complicated surgical relations which it has in that region, will serve to show that the operation, though not wholly impracticable, must be hazardous in the extreme. The greatest difficulty is encountered in the safe isolation of the vessel. Apart from this, the smaller size and greater length of this portion of the left subclavian would seem, by giving a better chance for the formation of a coagulum, to offer more hope of its safe obliteration than the ligature of the same portion on the opposite side. The only alternatives, where circumstances will not admit of the tying of the vessel more externally, are the method of Valsalva, the plans of Brasdor and Wardrop, or the seemingly shocking proposition of Mr. Ferguson to amputate the arm at the shoulder joint, and keep up afterwards regulated pressure on the diseased part. But these are so disheartening, as regards the prospect of a cure, that the operation upon the right side, even within the scaleni, must still be considered justifiable.

LIGATURE OF THE OUTER PORTION OF THE ARTERY, OR OVER THE FIRST RIB.

Lines of incision.—Surgeons vary in opinion in regard to the best method of making the external opening. Roux has proposed an incision nearly perpendicular to the clavicle along the outer edge of the sterno-cleido-mastoid. Ramsden, who first tied this vessel,† made his incision in the shape of a J reversed, the horizontal cut being made along the upper border of the clavicle. Physick recommended an incision in V; Hodgson one merely horizontal. Under ordinary circumstances, where simple ligature only is required, the horizontal incision of Hodgson will enable the operator with great ease and facility to uncover and tie the vessel. But in cases of large aneurismal tumour, which keeps the clavicle elevated, or where the neck is unusually thick and short, a necessity for a wider separation of the lips of the wound may exist. This may be gained, even during the course of the operation, by the addition of a vertical cut.

Ordinary process. (Pl. X.)—The patient is to be placed upon his back, with his chest moderately elevated, his head turned to the opposite side, and the shoulder carried downwards and backwards as much as practicable, in order to make tense the skin and muscles, and render the artery more superficial. The surgeon,

* By Mr. Colles of Dublin. The patient died on the ninth day.

† In 1809.

standing by the side of the patient, feels for the edge of the sterno-cleido-mastoid and trapezius, ascertains if possible the direction of the external jugular vein, and makes a horizontal incision merely through the skin, from near the edge of the trapezius, *on to the sternal edge of the first named muscle.* This gives in the adult an opening of about three inches in extent. If the individual be fat, the incision may, according to the direction of Lisfranc, be carried within an inch of the sternal edge of the clavicle. The wound should be about half an inch above the upper border of the clavicle.* Raise carefully on the director, and divide the superficial fascia and platysma, avoiding the external jugular vein, which may now be seen either at the external border of the sterno-mastoid, or at the middle of the wound. If it is in the latter position, and cannot well be drawn out of the way, it, as well as some other veins that are occasionally found in this place, must be tied with two ligatures and divided.† Some small arteries will have been cut, which may require to be tied. The wound carefully absterged with the sponge, and some loose cellular tissue broken with the point of the director, we come to a portion of the deep-seated fascia, which connects the omo-hyoid to the clavicle. This is to be cautiously opened, raised on the director, and, satisfying himself that there is no artery astride the instrument, the operator divides it. If an artery exist there, as I have occasionally seen, and it cannot be drawn out of the way, it must be tied and cut. With the point of the director or forceps, or with the finger nail, we tear the cellular tissue below the fascia, in which are lodged lymphatic glands and veins; at times some of the layers are found so resisting as to require to be raised on the director and touched with the point of the knife. The omo-hyoid muscle, which is now exposed, is to be drawn upwards and backwards by an assistant. The edge of the scalenus may next be felt and traced down to its tubercle of insertion; if the clavicular margin of the sterno-mastoid overlaps it, as it does in most muscular subjects, it should be divided for the space of half an inch or an inch. Before attempting to look for the vessel, the end of the fore finger should be brought in contact with the sharpened point of the tubercle of the first rib; if this is not readily found by tracing down the scalenus, carry up the finger along the rib from the external margin of the wound. Once found, we are sure of the artery, which is usually felt beating just at its outer side. But if the beating be obscure, or not at all obvious, as has been observed in consequence of a thickening of its coats, we may still satisfy ourselves, by pressure upon it so as to stop the passage of blood into the limb, that the rounded body immediately to the outer side of the finger is the vessel in question. The nerves of the brachial plexus, recognizable by their whiteness and hardness, will be found to the outer and back part of the artery. With the finger on the tubercle as a guide, move the point of the director up and

down upon each side of the vessel, so as to isolate it in its groove upon the rib; next conduct the beak of a bent director, or an aneurismal needle not too much curved, along the finger to the rib, between the vessel and the tubercle; insinuate it under the artery; then shift the finger over so as to depress the nerves, using it at the same time to guide and receive the point of the instrument as it is carried obliquely round the artery from within outwards, and from below upwards. On the left side it is equally if not more convenient, to enter the instrument between the artery and first branch of the nerves, and carry it from below upwards and from within outwards.

If the operation be featly performed, neither the subclavian vein, which lies in front and to the inner and lower part of the vessel, nor the superior scapular artery, will come into view during the operation. It has been proposed by Cruveilhier in cases where there was such difficulty in discovering the vessel as to lead to the abandonment of the undertaking, as happened to Sir A. Cooper, to saw through the clavicle and look for the artery below it. This has not yet been put in practice in the living subject, and as it would have to be done in all probability over an aneurismal tumour, the walls of which not unfrequently form an attachment to the bone, it is a proposition of very questionable utility. It would be much better, under the circumstances, to follow the practice of Dupuytren, and tie the vessel in the second part of its course by the following process.

LIGATURE BETWEEN THE SCALENI.

This does not, however, deserve to stand apart as a separate method; since the mode of its performance by a vertical incision, as first practised by Dupuytren, has been abandoned for the common transverse cut, made as described above. When the artery is to be tied between the scaleni, a measure which has often been practised with success, all that is required in addition to the former process, is to extend the incision of the skin inwards to near the sterno-clavicular articulation, divide the clavicular origin of the sterno-cleido-mastoid, and expose completely the front surface of the scalenus anticus, underneath which a director is to be passed downwards and inwards, and brought out immediately by the inner side of its insertion so as to avoid the phrenic nerve, which, after crossing it just above, is separated from it by a little triangular interval. The muscle is now to be divided on the director by cautious cuts, in order to avoid all risk of wounding the internal mammary at its origin, which lies more deeply and just at the outer side of the phrenic nerve. The retraction of the divided ends of the muscle leaves the artery exposed, which runs here obliquely upwards and outwards, and may readily be raised and tied. The common scapular artery I have often found, shortly after its origin, crossing the scalenus near the place of operation; it may easily be discovered by its pulsation, and drawn out of the way by an assistant. The vessel is here so much within and above the first rib, that no elevation of the humeral end of the clavicle can prevent our finding it. If from the commencement it was determined to tie the vessel between the scaleni, the incision of the integuments need not extend farther back than within an inch of the trapezius.

* Some operators direct the incision near the margin of the bone; others an inch above. But the height prescribed in the text, I find, as we proceed in the operation, furnishes the best security against the accidental wounding of the scapular artery, which is placed near the margin of the clavicle or the transversalis cervicis, which is an inch to an inch and a half above.

† The ligature of the vein, if it be divided, must by no means be neglected, and especially if there be any consolidation of its surrounding tissue, as there would otherwise be a possibility of air passing down it to the cavity of the heart, and producing a dangerous syncope. A large vein should be tied, when this is practicable, previous to its division.

LIGATURE WITHIN THE SCALENI.

If this perilous operation should be attempted on the living subject, the following process appears entitled to a preference over any other, as it exposes the field of operation more completely to the eye, and enables us to avoid the three principal and immediate sources of danger—the injury of the par vagum or its recurrent branch, and that of the internal jugular and subclavian veins. The general details of the operation will be much the same as for ligature of the innominata.

The patient is to be placed as for the latter operation. The surgeon, standing at the end of the table, so as to look over the patient's head, makes an incision, beginning in the fossa at the top of the sternum, three inches in length, along the inner border of the sterno-cleido-mastoid. A second transverse one, commencing half an inch above the top of the sternum, is to be carried from the first, just beyond the sterno-clavicular articulation. The fascia superficialis and a layer of the deep-seated fascia, which extends to the border of the muscle, are to be divided along the vertical incision. The sternal portion of the muscle is also to be cut and drawn upwards by an assistant. The sterno-thyroid and hyoid muscles are next to be cautiously raised on a director and divided. With the finger or the handle of a scalpel, the operator clears away the cellular tissue at the bottom of the wound, keeping to the outer and lower part, in the direction of the inner end of the clavicle. The aim is to expose the artery between the par vagum nerve and the internal jugular vein. In consequence of the oblique direction outwards of the latter, sufficient space is here found to pass the ligature. The aneurismal needle in passing round the artery should be kept closely in contact with it, and at the same time be directed upwards and outwards in order to avoid injury of the pleura, (which was wounded in the operation of Mr. Colles,) and the inclusion of the recurrent nerve, which is sent upwards and inwards round the vessel. If applied at this point, the ligature will rest at the inner side of the origin of the branches given off by the subclavian. The exact position of the internal jugular and par vagum ought to be previously ascertained, and both held carefully out of the way with a blunt hook. Either of these might serve as a guide to find the vessel. If the surgeon work too much at the inner border of the wound, he will fall on the carotid. This vessel may then, however, as in the operation on the innominata, be followed downwards to the origin of the subclavian, and the latter traced outwards, for the space of three-quarters of an inch, to the point where the ligature ought to be applied, just at the outer border of the par vagum.

If the ligature of this artery should be attempted on the left side, the same process would be found the most appropriate. Great care would be required to avoid injury of the pleura and of the thoracic duct which are close behind the vessel. Greater embarrassment would be presented on this side by the inferior thyroid and deep cervical veins; the latter forming a large trunk immediately in front and nearly parallel with the artery.

OF THE BRANCHES OF THE SUBCLAVIAN.

The arteries furnished by the trunk of the subclavian, which may in case of necessity, be exposed and tied, are the vertebral, inferior thyroid, and internal mammary. The necessity for secur-

ing the other two branches given off is little likely to occur; it could only exist in case of an accidental wound, at the bottom of which they might be found and tied.

Of the vertebral.—This artery runs up to the brain, through the foramina in the transverse processes of the six upper cervical vertebræ. Two instances of wound of this artery in its course have been lately reported. One, that of a French soldier, stabbed in the back of the neck with a knife, the point of which divided the artery between the transverse processes. The other case, in which the artery was divided by a side cut made upon the throat with a razor, occurred in this city. In both, the hemorrhage was fatal. In such cases there is no resource, when the nature of the injury is ascertained, save ligature of the vessel at its origin, or of the subclavian trunk. The former, when practicable, is of course to be preferred. The parts are to be opened precisely in the same manner as for ligature of the subclavian between the scaleni. With the finger carried to the bottom of the wound, we may feel, about two inches above the clavicle, the projection of the transverse process of the sixth cervical vertebra, distinguished as the carotid tubercle by M. Chassaignac. The vertebral artery is found immediately below this projection, when about to enter the foramen at its base, just at the inner margin of the scalenus anticus. Nuntiante Ippolito* relates two cases, in which this artery was tied at its origin with success.

Inferior thyroid.—This vessel passes a little above the carotid tubercle in a direction upwards and inwards behind the sheath of the carotid artery and jugular vein, to reach the lower border of the thyroid gland. To find this artery, an incision may be made along the inner border of the sterno-cleido-mastoid. The muscle is then to be drawn outwards with a blunt hook, and the sheath of the vessel separated from the side of the trachea and œsophagus. The artery, though somewhat variable in regard to its origin, will be found in its course to the outer side of the recurrent laryngeal nerve. Several thyroid veins cross the line of operation. If it becomes necessary to seek the vessel near its origin, the same process as described for ligature of the vertebral will answer. The thyroid originates from the subclavian, just before it enters between the scaleni, and commonly at the outer side of the vertebral.

Internal mammary.—This vessel runs down obliquely by the side of the sternum, between the pleura and the posterior face of the costal cartilages, and intercostal muscles. In the middle part of its course it is near half an inch distant from the side of the sternum, but is almost in contact with it below. In case of aneurism or wound of the vessel, it may very readily be exposed and tied in the third or fourth intercostal space. The operation has not, however, been done on the living subject.

Operation.—Make an incision through either one of these spaces, outwards from the side of the sternum for the distance of an inch and a half, in the middle line between the costal cartilages. Divide the intercostal muscle cautiously on a director, upon the thin aponeurosis which is stretched between the ribs, and we perceive the artery, which may readily be isolated from its veins, and raised and tied without risk of injuring the pleura. Scarpa recommends the incision to be made between the first and second ribs, dividing the pectoral as well as the intercostal muscle. But

* Froriep's Notizen, 1835. S. 304.

this position should not, except in case of emergency, be selected, as the position of the artery is here so close to the sternum as to offer some embarrassment.

OF THE AXILLARY ARTERY.

We understand by this name, that portion of the arterial trunk of the upper extremity, extending from the lower border of the first rib to the inferior border of the tendon of the latissimus dorsi muscle. It is continuous above with the subclavian, and below with the brachial.

Surgical anatomy.—The axilla or armpit is that space between the side of the chest, and the inner side of the shoulder and upper part of the arm. It is triangular in shape, the apex being above at the outer termination of the inner third of the clavicle. The base which is below is bounded by the tendon of the pectoralis major in front, and by the tendons of the latissimus dorsi and teres major behind. The serratus magnus, which covers the side of the chest, forms its internal wall. The depth of this hollow between the tendons will vary according to the relative position of the arm to the trunk. When the arm is rotated outwards and raised to a right angle with the body, the depth is the greatest; but if the arm is carried still higher, the depth is diminished, as the head of the humerus then descends into the hollow, the folds of the axilla being overstretched. Through this space the axillary artery runs down in a line which is gently curved. The vessel is deeply placed just below the clavicle. Proceeding from without inwards, we find it here covered, 1st, by the skin, superficial fascia, and platysma muscle; 2d, by the thick belly of the pectoralis major, which arises by two sections with an intervening cellular space, one of which comes from the internal two-thirds of the clavicle, the other from the side of the sternum; 3d, by the pectoralis minor muscle the fleshy tendon of which, running to the coracoid process, crosses the artery about an inch below the clavicle. From this tendon a dense cellular layer* passes to the subclavius muscle, covering the artery above; and another descends into the armpit, covering the vessel below. When these two aponeurotic layers are laid open, we find the artery divided as it were by the pectoralis minor, into three portions; one between it and the clavicle; one immediately behind and covered by it; and a third situated below the muscle, or, more properly speaking, at the inner border of the arm, near the lower margin of the armpit. In each of these three positions the artery has been the subject of operation.

1. When the clavicular portion of the pectoral muscle is raised, the upper portion of the artery is found lodged in a sort of triangle, the base of which is formed above by the middle third of the clavicle, the inner side by the upper edge of the sternal portion of the pectoralis major which runs from above downwards and outwards, and its outer side by the pectoralis minor, which runs from below outwards and upwards. The artery is placed between the brachial plexus of nerves, (which lies here, to its outer and posterior side,) and the great axillary vein, which lies to its inner side, slightly overlapping it in front. The plexus is separated from the artery by a cellular interval, and consists here of

two large trunks which lie side by side. The great cephalic vein of the arm crosses this triangular space immediately in front of the artery, to throw itself into the axillary vein. Three branches, the superior, the inferior, and acromial thoracic, are given off from the axillary artery in this triangle, immediately below the course of the vein. Sometimes they come off by a single and sometimes by a double trunk.

2. *The middle part of the axillary artery*, or that behind the pectoralis minor muscle, is completely surrounded by the plexus of nerves, behind which is seen the subscapularis muscle. Several arterial branches are given off at this point. The axillary vein is still found at the inner side of the artery, and is here crossed by the small nerves which go to the thorax.

3. Below the pectoralis minor, the artery is found crossing near the head of the os humeri, and passing down to the inner border of the coraco-brachialis, at the junction of the anterior with the middle third of the space included between the tendons of the pectoralis major and latissimus dorsi muscle. It is here so superficial, that when the arm is thrown out from the body its position may be noticed under the skin and brachial aponeurosis, which alone cover it. The artery is either found between the two roots of the median nerve, or between this nerve and the internal cutaneous. The latter nerve soon takes a position in front of the artery. The vein and the other nerves of the arm given off from the plexus are placed to its inner and posterior side.

Anastomosis.—In ligature of the axillary artery, high up, the same vessels are concerned in restoring the blood to the arm, as in the common operation on the subclavian. If tied below the origin of the subscapular and circumflex, these vessels, by their anastomosis with the profunda and other branches of the brachial, become the channels of communication.

Remarks.—Ligature of the axillary artery has been called for in cases of wounds and aneurisms at the upper part of the arm. When the circumstances of the case admit of the application of the ligature in its lower portion, which is, however, rare, the operation is perfectly simple and easy. But in the upper part of its course, in consequence of its depth, the thickness and transverse direction of the muscle which covers it, its intricate connection with the nerves of the brachial plexus and the axillary vein, and the number of secondary vessels which are liable to be cut in reaching it, it is justly considered one of the vessels the most difficult to secure. Dupuytren was compelled in one case to tie twelve or thirteen arteries which were divided in the operation. In the hollow space below the clavicle, the true aneurismal tumours of this vessel, when they have attained much size, usually make their appearance. In false aneurisms of some standing, the loose oozy cellular substance placed about the vessels and filling up the whole axillary space as high as the region of the clavicle, yields readily to the pressure of the effused blood, from which region, owing to the peculiar arrangement of the fascia of the part, the fluid is notable to escape. The sac of a large aneurism is in consequence modeled on the form of the axillary space; thus rendering it almost impossible to expose the artery below the clavicle, without opening the sac.

For these various reasons, surgeons of the present day usually prefer, and especially in cases of aneurism, to cut above the clavicle, and tie the subclavian in the third part of its course. Seve-

* Commonly called the costo-coracoid membrane, from its connection at its inner end with the costo-coracoid ligament.

ral surgeons of distinguished eminence, White, Pelletan and Desault, in attempting to tie the artery below the clavicle, have been compelled, from the difficulties they encountered, to terminate their operations unsatisfactorily. It has, however, been many times successfully tied in this region; and in suitable cases, where we have reason to believe the artery is healthy, and that the aneurism has not encroached upon the subclavian hollow, the desire to place the ligature as far from the heart as we can with safety, leaving room for a second operation on the subclavian in case of disaster from secondary hemorrhage, the process will still be practised. The ligature of the vessel immediately behind the pectoralis minor has been justly abandoned, leaving now but two points for operation;—that above the pectoral muscle, and that in the hollow of the axilla. There is one circumstance which the surgeon should bear in mind, that occasional instances of anomaly occur, where the axillary divides into its radial and ulnar branches as high up as the subclavius muscle.

1. *Ligature above the pectoralis minor, called the high operation upon the axillary, and sometimes spoken of as ligature of the subclavian below the clavicle.* (Pl. XII.)

a. *Ordinary process.*—*Horizontal incision.*—The patient is to rest upon his back with his head and shoulders raised, the shoulder of the diseased side moderately elevated, and the elbow carried out from the body at an angle of forty-five degrees. Compression may be made by an assistant upon the artery above the clavicle. The surgeon then, depressing with the fingers of the left hand the clavicular portion of the pectoralis major muscle, makes, half an inch below and parallel with the clavicle, an incision through the integuments and platysma muscle, three or four inches long, extending from near the margin of the deltoid muscle to within an inch of the sternum.* The fissure between the deltoid and pectoral muscles, may previously be readily ascertained by putting them into contraction; in this fissure is lodged the cephalic vein, which must be carefully avoided. Next, the whole thickness of the pectoral muscle is to be divided layer after layer for the entire length of the wound, tying or twisting the branches of the thoracic arteries as they spring, which, though not large in their normal state, are found dilated in cases of aneurism. Having reached the posterior face of the muscle, (in doing which there is usually little difficulty,) the firm aponeurosis behind it is to be divided on a grooved director. The subclavicular triangle is now exposed; the lower and outer boundary of which,—the pectoralis minor—may be felt with the finger, and will serve as a guide to find the vessel which lies at its upper and inner side, between it and the clavicle, surrounded by some loose cellular tissue that is covered in with a thin fascia connected with this muscle. The arm is now to be brought to the side of the trunk, and rotated inwards so as to put the parts in complete relaxation. With the end of the finger or the point of a director, we cautiously break up the cellular structure in the triangle, and lay bare the edge of the pectoralis minor, which is afterwards to be held downwards and outwards with a blunt hook, or the fore finger of an assistant. Sometimes the fascia running up from the pectoralis minor is so strong as to

require to be raised with the director and touched with the point of the knife; but care must be observed in so doing to avoid wounding the thoracic vessels which are placed immediately below. The cephalic vein will usually be seen crossing just below the clavicle to reach the axillary vein; this may, if it impede the operation, be drawn upwards by an assistant. Of the parts within the triangle, the first exposed to view is the axillary vein. This is seen swelling up at each expiration, partially covering the artery, which is placed behind and to its outer side, and to which it serves as a guide. With the point of a director passed in at the groove at the outer side of the vein, we separate this from the artery and draw it carefully downwards and inwards with a blunt hook. The artery is now to be separated in like manner from the plexus of nerves, which is found without and *behind* it. The bent director or the aneurismal needle is then to be passed from between the artery and nerves upward and inward, bringing it out between the artery and vein, the latter of which is to be carefully guarded against laceration by being pressed off with the fore finger of the other hand, which serves at the same time as a point of support to the end of the instrument. I prefer to pass the instrument from without inwards, as there is less risk of including one of the branches of the brachial plexus,—an accident which has several times occurred in the operation; it is even passed with greater facility in that direction, since the needle moves from the deeper to a more superficial point of the wound. The ligature is to be placed as far as possible above the origin of the thoracic arteries, lest the blood passing through these vessels should prevent the formation of a proper clot.

b. *Transverse curvilinear incision.* (Process of Hodgson.)—The principal object of this process is to expose largely the subclavicular triangular fossa, in which are lodged the vessels and brachial plexus. A semilunar incision convex downwards is directed to be made below the clavicle, extending from the sternal end of the clavicle to near the point of the acromion scapulæ and carried through both the deltoid and pectoralis major muscles. The flap of muscles is to be drawn upward, and the vessel is then isolated and tied according to the method above given. The injury done to the soft parts in this operation is, in ordinary cases, unnecessarily extensive. It may however be found justifiable, when it is considered requisite to expose completely a circumscribed aneurismal tumour in the subclavicular fossa. If the line of the incision be limited externally to the fissure between the deltoid and pectoral muscles, after the manner of Dupuytren and Velpeau, the objection will be in a great measure obviated.

c. *Angular incision.* (Process of Chamberlaine.)—A horizontal incision is made in the usual manner below the clavicle. A vertical incision is dropped from the outer angle of this in the space between the pectoral and deltoid, carefully avoiding injury of the cephalic vein, which is closely adherent to the deltoid, as well as a branch of the thoracic acromial artery lodged in the fissure. The incision will have the form of an Γ reversed. The triangular flap formed by these two incisions is to be drawn inwards and downwards. The pectoralis minor will be brought to view just at the inner margin of the deltoid, and immediately above it will be found the vein, artery, and nerves. This process exposes the artery well in the neighbourhood of the pectoralis minor, which may at want be cut and the artery looked for behind

* In very fat or muscular subjects the incision may, if necessary, be carried still nearer to the sternum, the operator recollecting that the artery is to be found considerably to the outer side of the internal third of the clavicle.

next the fore finger of the left hand under the clavicular portion of the muscle, opposite the middle of the clavicle, we divide it through from without inwards by a careful use of the knife. The direction of the incision must be obliquely upwards and outwards, at right angles with the course of the clavicular fibres. Few arteries will be cut; but such as are of much size must be tied at once, to prevent the blood obscuring the latter steps of the operation. The divided portions of the muscle will retract and may be still further separated with blunt hooks so as to leave a wide triangular space in which we are to hunt for the vessel. The posterior fascia of the pectoral muscle is to be opened in the same line on the director. Below this fascia is seen another running from the pectoralis minor to the subclavius muscle. This must be raised with the forceps and torn with the point of the director, or divided cautiously so as to avoid injuring the thoracic arteries which are placed immediately below it, or their common trunk which stands out prominently. If we desire to tie the artery near the clavicle, we break away the cellular tissue in a similar manner, *above* the origin of these thoracic vessels. Crossing near the upper margin of these vessels is seen the cephalic vein of the arm, and above this the artery is found deeply lodged on the first interosseous muscle, with the great axillary vein at its inner side, thrown somewhat more in front by the rising prominence of the rib. The nearest root of the brachial plexus is placed nearly a quarter of an inch behind and to the outer side of the artery. A small vein is seen crossing in front of the artery to the great venous trunk, and between this and the cephalic, (which is to be gently drawn downwards,) we isolate the artery first on its inner and then on its outer side, and pass the ligature from within outwards and backwards, bringing the arm close to the trunk at the time, so as to relax the vessel. If it be deemed expedient to tie the artery at the upper margin of the pectoralis minor, this muscle, if it has not been previously exposed, is to be brought fully into view by breaking away the cellular aponeurosis along its upper border, which will be found on a line drawn from the point of the coracoid process to the junction of the second rib with the sternum. The muscle is then to be drawn downwards with a blunt hook in the direction of the lower angle of the external incision, and the cellular tissue opened as above directed between it and the origin of the thoracic artery. The artery will now be found raised from the ribs over the second head of the scalenus anticus, with the vein within and a little posterior to it, and the first branch of the brachial plexus close at its outer side and slightly overlapping it. The artery is to be isolated with care, and the ligature passed round it, the brachial nerve being pushed outwards with the left fore finger so as to prevent its being included in the loop. After the operation, the parts are to be drawn together by a single suture passed through each angle of the integuments above, and secured to the skin on the opposite margin of the wound. This method of proceeding admits of a ligature being applied upon the artery in any part of its course, which is more than an inch in extent, between the clavicle and the lesser pectoral muscle. It will, I believe, be found attended with less difficulty on the part of the operator, with less hemorrhage, and less liability of injuring important parts, than any other that has been devised.

Marjolin and Lisfranc have proposed to tie the axillary artery by simply opening the interstice between the two portions of the

pectoralis major. But the artery by this plan will be uncovered too low, and the resistance offered by the contraction of the undivided muscle would render it nearly inapplicable in the living subject. Could it be accomplished, the opening left would not be sufficiently free to admit of the escape of the purulent secretion which is apt to follow the disturbance of the cellular tissue of the part.

2. *Ligature of the artery behind the pectoralis minor.* (*Process of Desault as modified by Delpêch.*)—The arm is to be carried out from the body at an angle of 45 degrees, and compression made upon the subclavian between the scaleni. An incision three to four inches in length is then made downwards and slightly outwards, from the junction of the external third with the two internal thirds of the clavicle, along the interstice between the pectoralis major and the deltoid, carefully avoiding the cephalic vein. The arm is now to be brought to the body, in order to relax the pectoralis major; the cellular tissue uniting the muscles along the interstice is to be divided with the finger or the point of the director, the border of the pectoralis major drawn downwards and inwards with the blunt hook or the finger of an assistant, and that of the deltoid carried in the opposite direction. The pectoralis minor is now exposed, and is to be raised on a director, and divided about three quarters of an inch from its place of insertion on the coracoid process. Passing the fore finger to the back and the outer portion of the wound, the mass of the vessels and nerves is to be hooked up and brought to the surface. The vein is then to be isolated at its outer side from the artery and carried inwards; the artery is next to be isolated from the nerves, and the aneurismal needle carried round it from within outwards. The objection to this process is, that the ligature is placed too near the origin of the thoracic vessels, and that the artery closely embraced by the nerves, cannot, from the depth at which it is placed, be brought to the surface without making strong traction upon the parts.

3. *In the armpit.* (*Process of Lisfranc, Pl. XII.*)—The arm is to be carried from the body so as to form an angle of 80 degrees with the trunk, and rotated outwards. We then feel at the inner edge of the coraco-brachialis,—just at the junction of the anterior with the posterior two-thirds of the armpit,* the pulsation of the vessel as well as the prominence formed by the brachial plexus of nerves. Along this artificial division of the axilla, a longitudinal incision of two to two and a half inches is to be made through the skin. The basilic vein, lodged in the thickness of the brachial aponeurosis, is then exposed to view along the internal border of the wound. This aponeurosis is to be opened and divided on the director at the external side of the vein. If a simple incision of the aponeurosis does not afford sufficient room to reach the vessel with facility, a cut may be made across the outer portion of the membrane. The vessels and nerves are now exposed. The arm is to be lowered in order to relax the parts; then proceeding from before backwards, starting from the coraco-brachialis as a fixed point, we find first, the median nerve, and immediately within it the axillary vein. Beyond, or to the inner side of the vein, are to be seen the internal cutaneous and ulnar nerves, and the basilic vein. The sheath of the vessels is to be carefully opened with the point of the director, and the vein carried inwards

* Half an inch to three quarters behind the tendon of the great pectoral, according to Manec.

and backwards. The artery will be found immediately within and behind the median nerve. Denude the artery slightly on either side, and pass the director below it, from within outwards, between the vein and median nerve. The above is the usual direction given, but I find it equally as convenient to carry the median nerve inwards along with the vein, and take up the artery between the nerve and coraco-brachialis. Occasionally the artery is found between the two long roots of the median nerve. It is then to be taken up between them. This method of Lisfranc is the easiest process for ligature of the axillary artery, but is only applicable in affections of the brachial between the armpit and the elbow joint. Before beginning the operation it is well to mark first with the eye the position of the outer border of the scalenus, at the upper margin of the clavicle, which is an inch and five-eighths out from the sternal end of that bone; as this is in the line of direction of the axillary artery.

LIGATURE OF THE BRACHIAL ARTERY. (PL. XII.)

Surgical anatomy.—This artery, which is a continuation of the axillary, descends in a straight line in the muscular groove found between the inner edge of the coraco-brachialis and biceps in front, and the triceps extensor cubiti behind. About an inch and a half above the elbow joint, it bends slightly outwards along the interior edge of the biceps, and crosses the face of the brachialis anticus so as to reach the middle of the bend of the arm. At this point, it is covered by the aponeurotic expansion sent off inwards and downwards from the tendon of the biceps, and divides into the radial and ulnar arteries, just at the insertion of the muscle on the tuberosity of the radius. The brachial artery, in a subject moderately muscular, is found about half an inch below the surface. It is covered by the integument, a superficial fascia consisting of two thin layers, and a deep-seated muscular or brachial aponeurosis. Just above the elbow joint, it is slightly overlapped by the internal edge of the belly of the biceps. On its inner side, and in close connection, is found the trunk of the brachial vein; but where there are two satellite veins, the artery is placed between them. The median nerve has important relations with the artery, and serves as a guide for its discovery in ligature of the vessel. At the superior and middle third of the arm, the nerve is found at the external and front margin of the artery. About two inches and a half above the elbow joint, it crosses obliquely in front of the artery so as to get completely to its inner side. The ulnar nerve passes down the arm at some little distance within and behind the artery, in the direction of the back part of the internal condyle. The internal cutaneous is found at the inner surface and somewhat in front of the vessel. The vessels, in their descent along the arm, are surrounded by loose cellular tissue rather than a distinct sheath. The artery, in a healthy state of the parts, can be felt pulsating through the skin, and may be tied in any portion of its course.

Anomalies.—Nothing is more common than anomalies in the distribution of this vessel. It may divide, as before observed, into its radial and ulnar branches as high as the armpit; or at any part of its course down the arm. The frequency of this irregular distribution should be well understood. It is said by Prof. Quain to occur in one case out of five. Fortunately, it may usually be detected by careful examination; otherwise, the surgeon might

become embarrassed in attempting to check a hemorrhage or cure an aneurism, in finding that he had exposed a vessel which was not the subject of disease. He may, before beginning the incision, by alternately compressing the respective branches, be able to discover which is the proper subject of operation. It may be necessary even to tie both branches, as they are sometimes found to have direct communication with each other at the elbow; and this double operation could be attended with no greater danger than the single ligature of the undivided trunk. In cases of division high up, the branches are usually found running down near together, (the radial usually being the more superficial and external,) to the neighbourhood of the elbow joint where they diverge.

Anastomosis.—The anastomosing branches by which the circulation is carried on after obliteration of the brachial trunk, are the profunda major, profunda minor, and the anastomotica on the part of this artery. The profunda major is usually given off near the armpit, the principal branch of which, the musculo-spiral, winding round the bone with the nerve of that name, forms a continuous trunk with the recurrens radialis in front of the external condyle, and is connected also by a branch with the interosseal recurrent at the back part of the joint. The profunda minor, descending behind the brachial artery as far as the middle of the arm, sends a branch of considerable size down with the ulnar nerve behind the inner condyle, which inosculates with and forms a continuous tube with the recurrens ulnaris. The anastomotica, coming off an inch or two above the elbow joint, winds across the brachialis anticus, and divides into two branches, one of which, passing in front of the outer condyle, unites with the radial recurrent, and the other dips down between the capsule and olecranon process to anastomose with the interosseal recurrent.

Remarks.—The brachial artery, in consequence of its proximity to the bone, may be readily compressed in any part of its course with the extremities of the fingers or a compress and bandage. If the latter means be used, the compress should be of moderate size, so as to admit of being pressed under the edge of the biceps. It is well to avoid making compression at the point where the artery passes over the insertion of the coraco-brachialis muscle, as here the median nerve is placed in such relation to it as to be painfully affected by the force applied.

From the mobility and exposed position of the arm, and the frequency of venesection at the elbow, it is of all the larger arteries most exposed to traumatic injury. If there be lesion of the vessel above the elbow, we may tie it either at the place injured, or, if there is such infiltration of blood as to mask the parts, cut down upon it in any point above. In case of puncture of the artery in venesection at the elbow, the course to be pursued varies according to circumstances. Pressure made with graduated compresses, covered with a piece of coin or other metal, or with a special apparatus for the purpose, may, particularly if the wound be longitudinal, so diminish the calibre of the vessel as to allow the wound both in the artery and vein to heal. But to succeed, it must be immediately applied, and is not even then a certain measure. If it fail, or the case be altogether neglected in its first stage, even though the wound on the two surfaces of the vein should heal, we may have a false aneurism developed in its sheath or in the surrounding cellular tissue, constituting a resisting

pulsating tumour below the bicipital aponeurosis, limiting the extension of the arm, and as it grows in size bulging up just above the upper margin of this membrane, where the fascia is weakest.

Or there may be instead, direct communication between the artery and superficial vein. The posterior wound in the vein and that of the artery not healing by first intention, and being brought into close contact by the compression necessary to stop the hemorrhage, the blood of the artery leaves its route to the hand, and turning in a direction in which it meets less resistance, forms an oblong prominent pulsating tumour in the superficial veins at the elbow, constituting what is called a varicose or arterio-venous aneurism.

The communication, as has been observed, may be made directly between the artery and the superficial vein, both of which become matted together by the effects of the compression, and closely adhere to the opposite surfaces of the intermediate bicipital aponeurosis; or it may be indirect, the cyst of a circumscribed false aneurism being formed, which receives the blood at its bottom through the opening in the artery, and discharges it at its top, through the orifice in the posterior wall of the vein. The puncture in the anterior wall of the vein is always found closed through union by first intention.

Or another kind of arterio-venous aneurism may be formed; the artery first pouring out its blood into one of its satellite veins, through which as well as the superficial vein, the lancet has in that case passed; the two orifices of the latter vein healing up, while the blood of the artery poured into its satellite, finds its way through the deep communicating radial vein (see page 16) into the superficial veins, and generally into the median basilic, which is often found dilated and pulsating in all its course up the arm. Three cases only of this description have been well reported,* and a fourth has lately occurred in this city, which came under the notice of Dr. John Wilson Moore, with whom I saw the patient in consultation. But they must be unquestionably of much more frequent occurrence; for the manner in which the satellite veins overlap the brachial artery, show that they are more or less exposed to injury whenever the lancet is carried so deep as to open the latter vessel; and the discrepancies which exist among writers, in their description of arterio-venous aneurism at the bend of the arm, show that the pathology of this form of the disease has been but imperfectly understood. This latter form, to which, for the sake of distinction, I would restrict the name of aneurismal varix, is an affection not to be lightly attacked by an operation, and perhaps only with safety in its early stages; a retaining bandage or a laced sleeve, serving even where the disease is advanced, to check the distension of the vein, and preserve in a good degree the uses of the limb. Each vein, cut in these cases at the bend of the elbow, bleeds as an artery in consequence of the arterial blood being mainly directed through the veins. Profuse irrepressible hemorrhage, gangrene, and subsequent death, followed an attempt to cure by operation an aggravated case of this kind, in the hands of M. Roux.† It is to be distinguished from the ordinary kinds

of aneurismal varix, by the general dilatation and pulsation of the vein, (owing to the oblique direction in which the blood comes from the communicating branch,) rather than by a single rounded prominence; by the fact that the blood is found to enter below the cicatrized puncture of the vein; and that by pressure of the thumb below the puncture so as to flatten completely the communicating vein, we stop without arresting the action of the artery all pulsation in the superficial vessels. In the commoner form of aneurismal varix, when the communication between the superficial vein and artery exists at the place of puncture, either directly or by the intervention of a cyst formed out of the intermediate cellular tissue, pressure made as described, at the entrance of the communicating vein, will have little or no influence on the pulsation of the superficial vessels.

As soon as the injury of the artery by venesection or other means is detected, it is incontestably the surest course at once to recur to the ligature of the vessel, in order to prevent either of the consequences that may follow—the common form of false aneurism, varicose aneurism, or that to which I have limited the term of aneurismal varix. Two methods of proceeding are then open to the practitioner—to incise the parts at the bend of the arm, and tie the artery above and below the place of puncture; or follow the method of Hunter, and tie it where it is more readily exposed in its course along the biceps muscle. If the operation be done *shortly after the occurrence of the injury*, the former method is not ordinarily the best, inasmuch as it is desirable to avoid an incision at the elbow, in consequence of the deeper covering of the artery, its complex relation with the veins of that region, and its obscurity from the extravasation of blood which to more or less extent takes place. The method of Hunter is a more simple process, and if soon applied is equally successful; for it has been fully proved by experience, that the anastomosing vessels will not dilate so as to restore the circulation of the wounded trunk till sufficient time has been allowed for the healing of the puncture made in it by the lancet; and to this, compression may if necessary be added at the bend of the arm. A great accumulation of effused blood at the bend of the arm, pressing on the origin of the recurrent radial and ulnar arteries, might, however, as a case of exception, render it better to cut down, turn out the clot, and tie the brachial above and below the place at which it is wounded.

The principles involved in the Hunterian operation of tying the artery at a remote distance from the tumour, are not so binding here, where we have to deal with a sound vessel accidentally injured. A distant ligature, though it may answer if applied immediately after the injury, is not to be relied on in case much time has elapsed since the occurrence of the injury, if a large aneurismal tumour has been formed, or if compression has for some time been made from without; for from all these causes the anastomosing branches become enlarged, and the blood will find its way into the trunk at the elbow, both by the inferior arteries of the joint and the superior branch called the anastomotica magna. For these reasons I prefer always to tie the trunk an inch to an inch and a half above the joint and below the origin of the anastomotica. This simple operation has in my hands succeeded perfectly in four cases, which were respectively of four, five, eight, and nine weeks standing, in each of which, tumours of considerable size had already formed. In another of nine weeks stand-

* One by Park, of Liverpool, (Bell's Principles of Surgery. Vol. I. p. 302,) one by P. Adelman, (Tractatus Anat. Chirurg. de Aneurysmatice Spurio Varicose, Wurceburgi, 1821,) and one by Claudius Tarral, (Cyclop. Pract. Surg.)

† Vide Cyclop. Pract. Surgery, article Bend of Arm, by C. Tarral.

ing, a case of proper aneurismal varix, upon which firm pressure had been steadily kept up, so as to cause great enlargement of the profunda minor, the pulsation of the veins, though not entirely removed by the ligature of the brachial, was and still remains considerably reduced by the operation, so that the arm has been restored to very nearly its former degree of usefulness. A circumstance connected with the operation in this case is worth noting;—pressure made upon the brachial (which was a single trunk) through the integuments above the elbow, stopped all pulsation in the artery and veins below; the profunda minor, which was afterwards found greatly dilated, having been at the same time in the line of compression. But after the ligature of the brachial, the profunda served to keep up some pulsation in the vein, through its anastomosis with the vessels below the joint.

In old cases, the profunda minor has been found enlarged to a size nearly equal with that of the brachial, and in calculating the effect of a single ligature above the elbow, it is necessary that pressure should be made separately on the brachial trunk so as not to interrupt the current in the profunda minor. Such is the tendency to rapid dilatation of the branches in general about the joint, that in instances of longer standing than those already specified, and much less even if strong compression has been employed, the method of operation commonly deemed proper is the old plan of opening the parts at the bend of the arm, and tying the artery above and below the place of puncture. Yet there are unquestionable exceptions to this rule. Within the last two months the author has applied a *single ligature upon the brachial artery within an inch of the tumour*, in the case of an *elderly lady*, a patient of Dr. Ridgway, residing in Columbus, New Jersey. The tumour, which consisted of a varicose aneurism, was of sixteen weeks' standing, and of very large size. Pressure upon the brachial artery being found to arrest all pulsation in the tumour, and believing that the anastomosing vessels would yield less readily to the dilating forces in old persons, I deemed it proper to try the effect of a single ligature, in the manner above described. A complete and speedy cure was the result. The basilic vein was found as large as the finger, pulsating like an artery, and crossed the line of the incision just above the base of the tumour, rendering it necessary to observe great caution in the use of the knife in opening the sheath of the vessels. In conclusion, it may be observed that Dr. Colles, of Dublin, has stated that in no case of aneurism at the bend of the arm, has he found it necessary to open the sac, or apply more than one ligature, and that immediately above it.

LIGATURE AT THE MIDDLE PART OF THE OS HUMERI. (PL. XII.)

Operation.—The arm is to be moderately carried out from the body, the forearm placed in extension and supinated. The shoulder is to be sustained by one assistant, and the forearm and hand by another. The surgeon feels along the inner edge of the biceps (or of the coraco-brachialis, if the operation be done higher up) for the groove formed between it and the triceps, in which are lodged the vessels and nerve. Lisfranc's direction is, to place the four fingers of the left hand on the median nerve, and incise the skin along their inner border. But in the living subject, the pulsation of the artery itself forms a better guide. The cellular tissue may, however, from inflammation, be found so œdematous

and pasty, as to obscure both vessel and nerve. I prefer, therefore, in all cases, to cut neatly down immediately upon the internal edge of the biceps muscle, upon which the ends of three fingers of the left hand are to rest. An incision of two and a half inches in extent, beginning below, if it be the left arm, and above, if it be the right, is to be made first through the skin merely, for fear of wounding the basilic vein. The brachial aponeurosis is then to be opened and slit at the bottom of the wound its whole length on the director, the basilic vein being carried out of the way and to the outer side of the wound. Immediately adjoining the edge of the muscle, we find the median nerve. This, with the muscle, is to be drawn gently outwards with a blunt hook, or, which is to be preferred, the fingers of an assistant. Sometimes; however, from the position of the nerve, it will be found most convenient to draw it to the inner side. Below it is seen the sheath of the vessels, and to its inner edge, the internal cutaneous nerve; the ulnar nerve lying about half an inch farther back. The sheath is to be carefully opened and the artery will be found either lodged between two veins or with one large venous trunk at its inner side. Isolate the artery on either side with the point of the director, and glide the instrument below from within outwards, pushing up with the left fore finger the median nerve, so as to prevent its being raised with the artery. If by any blunder with the knife, the artery be wounded during the operation, the hemorrhage may be instantly arrested by pressure made above with the fingers of an assistant as shown in Plate VII. Some apply a tourniquet upon the arm, but this arrests the pulsation of the vessel, and renders the finding of it less easy. If used at all, it should merely be laid loosely upon the arm as a measure of precaution.

LIGATURE IMMEDIATELY ABOVE THE ELBOW JOINT. (PL. XIII.)

Operation. (*Process followed by the author for aneurism at the bend of the arm.*)—The arm, placed in the same situation as above described, an incision two and a half inches long is to be made over the inner edge of the inferior termination of the belly of the biceps. The lower end of the incision will be just above the fold of the elbow, and its direction will be upwards and slightly inwards. The skin alone is to be first divided. The superficial fascia is to be punctured on the edge of the muscle, raised on the director and carefully opened. The basilic vein will be found parallel with and to the inner side of the wound. The deep-seated or brachial aponeurosis is next to be raised and cut in the same manner. The inner edge of the biceps is now to be moved outwards with a blunt hook, and the basilic vein and internal margin of the wound carried in the opposite direction. Adjoining the edge of the muscle we observe first the median nerve, distinguished by its whiteness, which has crossed over in front and now lies to the *inner* side of the artery, covering the inner brachial vein; it is to be drawn inwards and the vessels will be seen about a quarter of an inch *behind* it, previously overlapped by the belly of the muscle. The sheath is to be carefully raised with the forceps, and opened with the point of the director. The artery is now seen lodged between its two satellite veins, from which it is to be isolated on the director. The ligature is then carried round it in the usual manner. Occasionally the median nerve has different relations with the artery, crossing behind it.

instead of in front, and getting at the place of this operation near a quarter of an inch to its inner and posterior side. In such cases the first part seen by the edge of the muscle would be the artery itself.

LIGATURE AT THE BEND OF THE ELBOW. (PL. XIV.)

Operation.—It is practised for recent traumatic injury of the vessel, for false aneurism, or one of the forms of arterio-venous aneurism. The arm is to be placed in the position, and secured as indicated above. The artery is to be compressed with a tourniquet or the fingers of an intelligent assistant. The surgeon ascertains with his finger the course of the artery from the middle of the elbow joint inwards and upwards along the inner edge of the biceps, and which is usually well indicated by the course of the median basilic vein. Depressing the skin in this direction with the fingers of the left hand, he makes an incision which should extend an inch above and an inch below the level of the condyles. The skin, which is very thin in this region, should alone be divided by the first incision. The median basilic vein and the internal cutaneous nerve will be seen lodged in the superficial fascia, at the inner side of the cut. Raise and open the superficial fascia carefully on the director, and carry the vein to either side that is most convenient;—usually it will be found easiest to move it downwards and inwards. The brachial aponeurosis next comes into view, strengthened at this point by the expansion of the biceps tendon. With the forceps, raise at the middle of the wound a fold of this double membrane, puncture it with the scalpel, and then open it upwards and downwards on the director. The artery and its veins and the adjoining nerves next come into view. To the inner side of the artery, and more superficial than it, may be felt first the median nerve at the top of the wound. At the middle of the elbow it is removed farther from the line of incision, and is sometimes not brought into view at all during the operation. The nerve, whether felt or seen, is to be carried gently inwards with a blunt hook. The sheath of the vessels, which lies about a third of an inch to the outer side of the nerve, is now to be opened in the usual manner, and the artery is found lodged either between two veins, or, as occasionally happens, with a single large venous trunk to its inner side. Isolate the artery from the veins with the point of the director, first upon its outer and then on its inner side; or if there have been much inflammation and thickening of the cellular structure, it may be necessary, as I have found it in one case, to raise the vein with the forceps, and separate it from the artery with gentle touches of the point of the scalpel. The director is then to be passed below the artery from within outwards, carefully excluding the vein or veins, and the ligature passed as usual. The passing of the director will be facilitated by a slight flexion of the forearm.

OF THE ARTERIES OF THE FOREARM.

LIGATURE OF THE RADIAL ARTERY.

Surgical anatomy.—The radial artery usually arises from the brachial near the bicipital protuberance of the radius, and descends

nearly in a straight line from the middle of the bend of the elbow to the inner margin of the styloid process, at the lower extremity of the same bone. In the *upper* half of the forearm the artery lies between the fleshy belly of the supinator radii longus on the outer side, and that of the pronator radii teres on the inner, and in thin subjects is covered only by the skin, superficial fascia and brachial aponeurosis; but in muscular subjects it is concealed by the edge of the supinator, which projects over it. It rests on the supinator brevis above, and somewhat lower on the tendinous insertion of the pronator radii teres. The radial nerve is placed above, at some distance on the outer side of the artery, and comes in contact with it only (and still at the outer side) near the middle of the forearm. The *lower* half of the radial is very superficial, lies just in front of the bone, and can be felt pulsating. It has the tendon of the supinator longus immediately at its outer side, and the tendon of the flexor carpi radialis within. It turns round the base of the thumb under its extensor tendons, to get to the back of the hand, and dips down between the metacarpal bones of the thumb and fore finger to reach the palm, where it forms the deep-seated palmar arch. Before it turns to the back of the hand, it sends a branch over the ball of the thumb to form a direct anastomosis with the ulnar or superficial arch. This branch, the *superficialis volæ*, is sometimes so large that when cut it will require to be tied, or have a ligature thrown upon the radial. The radial nerve is in contact with the artery only at the middle third of its course, leaving it four inches above the wrist to pass under the tendon of the supinator, and becomes cutaneous on the back of the hand. Two satellite veins attend the artery. The radial artery may be tied at its upper, middle, or inferior third.

Anomalies.—The principal anomalies in reference to the origin of this vessel and the ulnar have already been described. It may be observed, that the radial of one side sometimes receives the anterior interosseal artery, which, when large, serves to explain many of the cases of disparity existing in regard to the size of the arteries of the two wrists.

AT THE UPPER THIRD OF THE FOREARM. (PL. XIV.)

Operation.—The arm is to be extended and laid on its dorsal aspect. The artery is to be sought for along the inner margin of the supinator longus. If the artery can be felt pulsating, or this muscle can be made to contract so as to show its inner border, the line of incision is at once designated. But if neither of these rules can be applied, we are to recollect that the course of the artery at this region is exactly in that of a line drawn from the external border of the tendon of the biceps to the inside of the styloid process of the radius. In this direction the skin is to be incised for two inches, crossing the line of the vessel a little at its outer border. Any superficial vein crossing the wound is to be drawn to one side; the superficial fascia and brachial aponeurosis are to be divided on the director. The inner margin of the supinator is then to be sought for. The first yellow line observed starting from the lower and outer part of the incision, indicates the interval between this muscle and the pronator. The muscles are to be separated with the point of the director, and the supinator with its investing fascia drawn outwards. The artery and its veins are now exposed in their sheath, the radial nerve run-

ning down at a little distance on their outer side. The sheath of the vessels is sometimes seen masked with fat. Tear this as well as the sheath of the vessels with the point of the director, a fold of the latter being previously raised with the forceps. The vessel may now be isolated and secured in the usual manner.

AT THE MIDDLE OR LOWER THIRD OF THE FOREARM. (PL. XIII.)

Operation.—In either of these situations, the artery is superficial and the operation easy. Placing the arm in the position designated above, and tracing the line of the vessel already given, we find it pulsating at the inner border of the tendon of the supi-

nator longus. In the groove between this tendon and that of the flexor carpi radialis, we depress the skin and divide it for the space of two inches. The superficial veins and nerves crossing the wound are to be drawn to one side, and the superficial and deep-seated fasciæ divided. The sheath of the vessels is now exposed. This is to be opened, and the artery isolated and raised on the director, which is to be passed from within outwards.

LIGATURE ON THE BACK OF THE WRIST. (PL. XIV.)

Operation.—The radial artery may readily be tied on the back of the wrist, as has been proposed in case of wound of the deep-

PLATE XIII.—LIGATURE OF THE ARTERIES OF THE ARM.

(Fig. 1. A A²). OF THE ULNAR ARTERY IN ITS MIDDLE THIRD.

The incision is made along the radial edge of the flexor carpi ulnaris muscle. The position in which the arm is placed, to show the other operations, brings the wound *apparently* too near the inner edge.

- a. Forefinger of an assistant drawing off the inner lip of the wound.
- b. Blunt hook, of a convenient form, curved at the end so as to resemble in shape a bent finger, with which one lip of the wound and the flexor sublimis of the fingers are drawn outwards and depressed.
1. Line of division of the skin.
2. Section of the aponeurosis.
3. Flexor carpi ulnaris drawn inwards.
5. Flexor sublimis digitorum drawn outwards and depressed.
6. Ulnar nerve.
7. Ulnar artery, raised on the aneurismal needle.
8. Ulnar vein.

(B B²). OF THE RADIAL IN ITS INFERIOR THIRD.

The skin is divided along the inner edge of the supinator radii longus.

- 1, 2. Division of the skin and aponeurosis.
6. Radial artery between its satellite veins (7).

(C C²). OF THE ULNAR NEAR THE PALM.

- 1, 2. Section of the skin and aponeurotic layers.
5. Ulnar artery raised on an eyed probe, accompanied by a satellite vein (6) on either side.

(D D²). OF THE BRACHIAL JUST ABOVE THE ELBOW JOINT. (*Process of the author.*)

The incision is made over the inner edge of the biceps just above its insertion, and the lips of the wound widely separated to show the neighbouring parts.

- 1, 2. Skin and brachial aponeurosis divided.
3. Median basilic vein drawn inwards; a branch of the internal cutaneous nerve passing at its outer side.
4. Inner edge of the biceps drawn outwards.
5. Median nerve.
6. One of the deep-seated or satellite brachial veins, as seen in the subject from which this drawing was taken.
7. Brachial artery raised on the ligature from between its satellite veins.

(E E²). OF THE ANTERIOR INTEROSSEAL. (*Process of the author.*)

The incision is made at the lower part of the middle third of the arm, so as to cross slightly the intermuscular depression between the superficial and deep-seated flexor muscles.

Fig 1

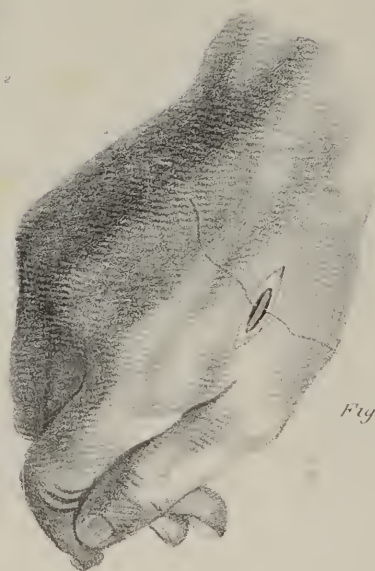
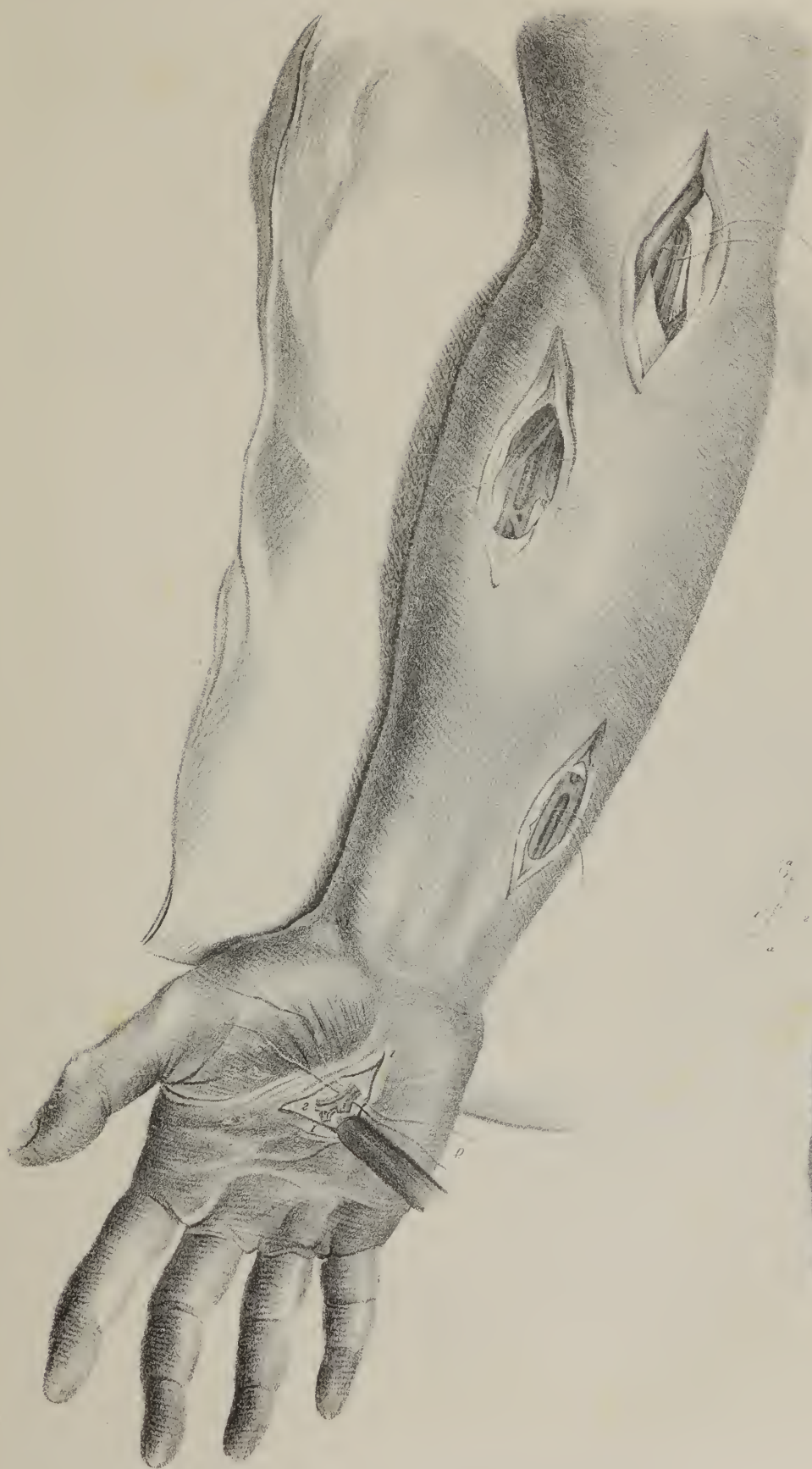


Fig 2

seated palmar arch. But the process is unused; preference being justly given to ligature of the radial in its lower third, since the volar branch would still be left to supply the superficial arch which is intimately connected by anastomosis with the deep-seated. To tie it on the back of the wrist, the hand should be placed in half pronation, with its radial edge upwards. The thumb is to be extended and abducted so as to render prominent the tendons of the extensor major, and the extensor minor pollicis manus. From the triangular depression between them, the artery will be felt pulsating in the cleft between the posterior extremities of the first two metacarpal bones, an inch and a half to an inch and three-quarters above the commissure of the thumb and forefinger. The tendon of the extensor major pollicis in a fleshy hand cannot be very distinctly felt; that of the extensor

minor pollicis, and that of the extensor ossi-metacarpi pollicis, lying immediately on the radial side of the extensor minor, can always be found. On the ulnar side of the two latter, the artery may be felt. Divide the skin between the tendons above mentioned for the space of an inch and a half, draw to one side the superficial radial vein and nerve, and open the aponeurosis below to the same extent on a director. The artery is then to be isolated from its veins, and a ligature placed about it in the usual way, just where it crosses the os trapezium to dip into the palm.

LIGATURE OF THE ULNAR ARTERY.

Surgical anatomy.—It arises from the brachial artery at the same point with the radial, and for the upper third of the fore-

1. Skin and brachial aponeurosis divided.
2. Flexor sublimis drawn outwards.
3. Deep-seated flexor muscle of the fingers drawn strongly inwards with a blunt hook, the fingers being flexed so as to relax the muscles.
4. Margin of interosseous ligament, seen below the fibres of the muscle over which runs the interosseous nerve. The nerve, before it is drawn outwards, lies slightly to the radial side of the artery.
5. Interosseous artery, with its vein (7). The artery is raised on a ligature.

(F). OF THE TERMINAL PALMAR BRANCHES OF THE ULNAR ARTERY.

These will scarcely ever require to be tied, except in case of wound. The palmar aponeurosis has been excised so as to expose the course of the vessel.

1. Ligature placed round the termination of the ulnar trunk, which has here formed the superficial palmar arch.
2. A ligature round the branch, by which it anastomoses with the radial.
3. Another ligature round a branch which goes to the outer side of the forefinger.

Fig. 2. This is intended to show the surgical relations of the ulnar and radial arteries in their descent.

- (A). 1, 1, 2, 2. Section of the skin and aponeurosis.
4. Humeral artery raised at its place of bifurcation.
5. Common radial vein.
6. Median basilic.
7. Median cephalic.
8. Deep-seated humeral or brachial.
9. Median nerve.
- (B). 1, 2. Section of skin and aponeurosis.
3. Flexor carpi ulnaris drawn inwards.
5. Flexor sublimis drawn outwards.
6. Ulnar nerve.
7. Ulnar artery between its two veins (8, 8).
- (C). 2. Section of the aponeurosis investing the artery over the anterior palmar ligament.
- 5, 5, 5. Ulnar artery between its two satellite veins (6).
7. Ulnar nerve.
- (E). 3. Tendon of the supinator radii longus.
5. Radial nerve.
6. Radial artery.
- 7, 7. Radial veins.
- (F). 2. Section of aponeurosis.
3. Pronator radii teres and palmaris longus drawn inwards.
4. Supinator muscle drawn outwards.
5. Radial attachment of the flexor sublimis digitorum.
6. Radial nerve.
7. Radial artery.
2. Inner radial vein.

arm runs obliquely downwards and inwards, under all the muscles which are attached to the internal condyle of the os humeri, and in the direction of a line drawn from the external border of the tendon of the biceps, to the radial margin of the ulna at the junction of its upper and middle third. The artery is here deeply placed, lying between the superficial and deep-seated layer of muscles, resting as it does on the anterior surface of the flexor profundus, and covered by the deep-seated aponeurosis which separates these muscular layers. In the middle and lower third of the arm, it runs perpendicularly downwards, in the course of a line drawn from the epitrochlea* of the os humeri to the radial margin of the pisiform bone. In its middle third the artery is

* The epitrochlea is the internal tuberosity of the os humeri above its surface of articulation with the ulna.

overlapped by the bellies of the flexor carpi ulnaris, and the flexor sublimis digitorum, which are often in muscular subjects united together by a line of dense yellow cellular tissue over the vessel. In the inferior third of the forearm the artery is lodged between the tendons of these muscles, and is superficial, being covered only by the skin, superficial fascia and brachial aponeurosis. From the side of the pisiform bone, the artery is extended over the annular ligament of the wrist so as to form on the palm the superficial palmar arch, and is covered by the skin, palmaris brevis muscle, some dense layers of fatty cellular tissue, and the palmar aponeurosis. It is attended by two satellite veins throughout its course. The ulnar nerve joins the artery just above the middle of the arm, and is continued down on its ulnar side to the palm. With the exception of the recurrent to the elbow, the ulnar artery

PLATE XIV.—LIGATURE OF THE ARTERIES OF THE FOREARM.

(Fig. 1. A².) OF THE BRACHIAL AT THE BEND OF THE ELBOW.

The integuments are divided in the direction of a line drawn from the middle of the space between the condyles of the humerus obliquely upwards and inwards towards the inner margin of the biceps muscle.

(A). Median basilic vein.

(B B). Aponeurotic expansion of the biceps, divided.

(C). Pronator radii teres.

1. Brachial artery with its accompanying vein.

2. Median nerve. The vein is seen lying between the nerve and the artery. The ligature is seen placed around the artery.

(B³). OF THE RADIAL AT THE MIDDLE THIRD OF THE FOREARM.

In the drawing, the operation is placed a little too high. The incision is made over the inner edge of the supinator radii longus muscle.

a, a. Superficial aponeurosis of the forearm divided.

(B). Supinator radii longus muscle.

(C). Outer edge of the flexor sublimis digitorum.

1. Radial artery raised on a ligature with a satellite vein on either side.

(C²). OF THE ULNAR ARTERY AT ITS LOWER THIRD.

The incision is made along the radial or outer edge of the flexor carpi ulnaris muscle.

a, a. Superficial aponeurosis divided.

1. Ulnar artery with its venæ comites.

2. Ulnar nerve.

(D). OF THE SUPERFICIAL PALMAR ARCH FORMED BY THE ULNAR.

The ligature of this vessel is rarely practised, except in wounds of the palm, which it is merely necessary to dilate in order to reach the vessel.

1. Incision of the skin.

2. Section of the palmar aponeurosis.

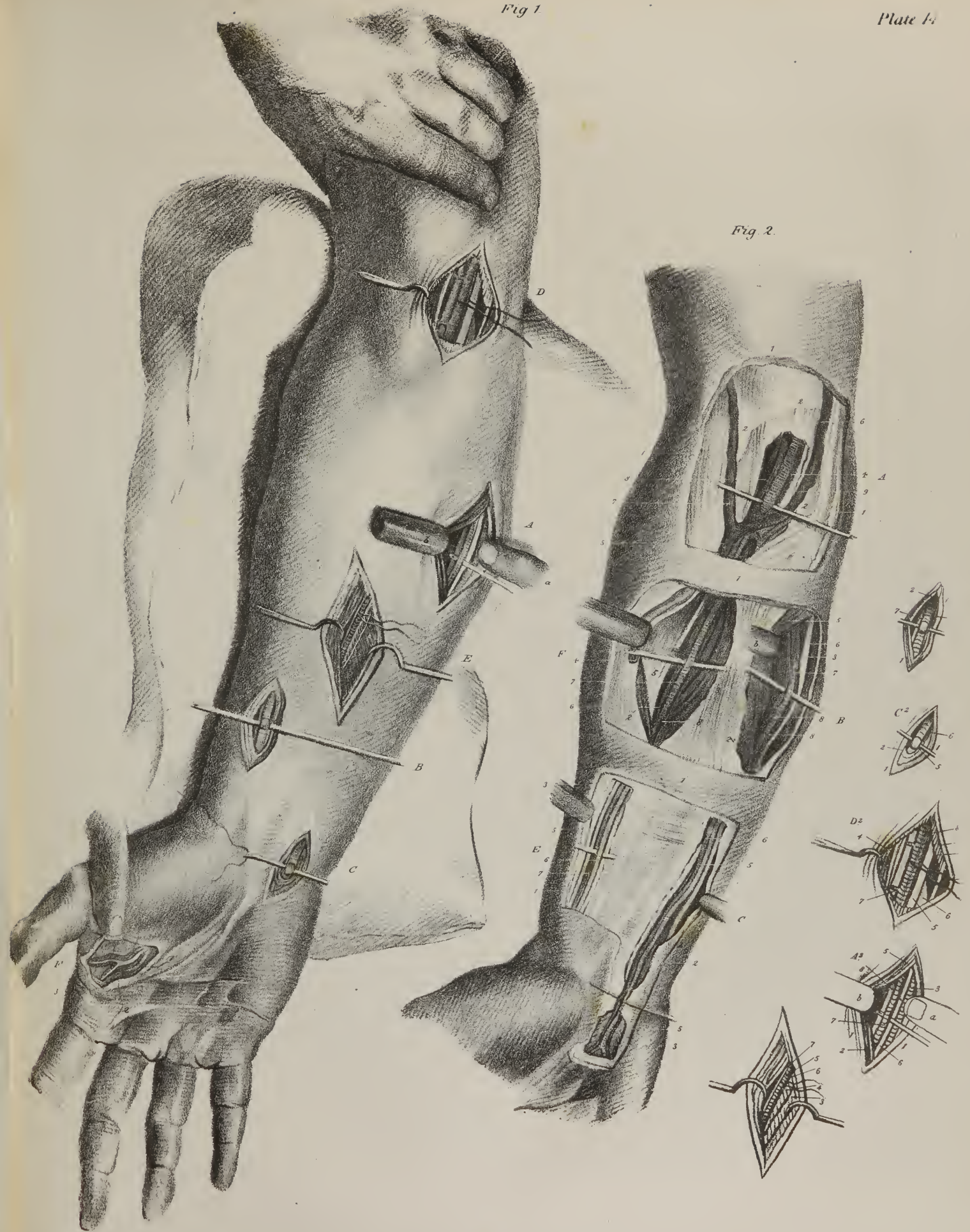
3. Ulnar artery between its two veins. One ligature is passed below the artery where it appears in the palm; and another under the first digital branch, which might continue the bleeding in the case of a wound, in consequence of its anastomosis with the deep-seated arch formed by the radial artery.

(Fig. 2.) LIGATURE OF THE RADIAL ON THE BACK OF THE HAND.

The skin and superficial aponeurosis are seen divided, and the artery raised on a ligature just before it sinks into the palm to form the arcus profundus.

Fig 1

Fig 2



gives off no branch of importance in its course down the forearm, except the common interosseous trunk. This divides into anterior and posterior branches; the former of which is the larger, and runs down on the face of the interosseous ligament, supplying the muscles in its course, and terminating by a branch which usually joins the superficial palmar arch.

Remarks.—From the numerous and large anastomosing branches which connect the radial and ulnar arteries in the palm, extensive wounds of this region will be attended with troublesome hemorrhage. If it be possible, by separating the lips of the wound or by dilating it a little with the knife, to discover the injured vessel, it is best to secure it with a ligature above and below the place of injury. If this cannot be accomplished, it will be necessary to tie the radial or ulnar artery according as the deep or superficial palmar arch is affected. The hemorrhage, however, is exceedingly prone to recur almost immediately, by a reflex movement of the blood from the anastomosing branches of the other vessel. If this happen, it will become necessary also to compress or tie the other main artery of the forearm. It has occurred to me in practice, to find the anterior interosseous terminating by so large a branch in the superficial palmar arch, as to keep up a troublesome hemorrhage from a wound in the palm, even after the radial and ulnar had both been tied, and ultimately rendering the ligature of the interosseous vessel also necessary. The ulnar artery may be tied in its upper, middle, or lower third. In its upper third it has been but once tied in the living subject.* From the depth at which it is here placed, it cannot be reached but by an extensive disturbance of the soft parts; and where the operation would seem called for by wound or false aneurism of the vessel above its middle, preference is in nearly all cases given to ligature of the brachial above the elbow. In a deep wound of the part, attended with hemorrhage, we could not, unless the bleeding vessel be brought into view, be certain whether the lesion was of the ulnar or the interosseal branch.

LIGATURE OF THE ULNAR NEAR THE TERMINATION OF ITS UPPER THIRD. (PL. XII.)

Operation.—The forearm is to be extended and held firmly in a state of supination. Recalling to mind the course of the artery in this region as above described, the operator makes an incision over it through the integuments from three to three and a half inches long, obliquely from above downwards and inwards. The incision should commence three fingers' breadth below the bend of the elbow, just within the junction of the inner with the middle third of the arm, and terminate on the edge of the ulnar bone. The superficial fascia and aponeurosis are then to be divided on the director, carefully avoiding the superficial veins if they are large. The surgeon, starting from the lower margin of the wound, looks for the first muscular interstice, designated by a yellow aponeurotic line about one-eighth of an inch broad, to which the fibres are connected on both sides. This indicates the place of junction between the flexor carpi ulnaris, which adjoins the ulna, and the flexor sublimis of the fingers. With the knife, open this aponeurotic line, and separate the muscles below with the finger or director. If the brachial aponeurosis offer any resistance to this

* By Marjolin.

step of the process, it is to be divided at the top of the wound transversely in the direction of the ulna. The hand is then to be flexed, the flexor sublimis slightly raised and drawn outwards, and we perceive first the ulnar nerve, and to the outer side of this the ulnar artery and its veins coming up from the depth, resting upon the flexor profundus and covered by the deep aponeurosis. Tear this aponeurosis with the point of the forceps, or, if it be firmer than usual, raise and divide it on the director. If the wrist be well flexed, the artery may be drawn toward the surface with a blunt hook or the common aneurismal needle. Having isolated it from its veins, the director is to be passed below it, and the ligature applied in the usual manner. By looking a little deeper and somewhat more towards the middle of the forearm we may raise and tie by the same process the interosseal trunk near its origin. Many surgeons direct a vertical instead of an oblique incision to be made through the integument. But the process, such as I have above described, I find much the most easy and successful.

LIGATURE OF THE ULNAR EITHER AT THE MIDDLE OR INFERIOR THIRD OF THE FOREARM. (PL. XIII. and XIV.)

Operation.—The limb placed in the position above designated, the course of the artery is to be traced according to the rules given. In most cases, it may be detected by its pulsation. An incision of two and a half to three inches is to be made, slightly crossing over the line of the vessel towards the ulnar bone. The superficial fascia and aponeurosis are next to be divided. At the middle part of the forearm, we open the first muscular interstice next the ulna, which will be that between the flexor ulnaris, and the flexor sublimis digitorum. At the inferior third the artery is placed between the tendons of these muscles, and we are to separate and draw slightly inwards the tendon of the former which slightly overlaps it. The artery is found lodged on the flexor profundus, and is to be secured in the usual manner.

LIGATURE OF THE ULNAR BELOW THE PISIFORM BONE. (PL. XIII.)

Operation.—The artery runs down on the radial side of the pisiform bone, in the same direction that it has above, for about an inch and a quarter, when it turns outward to form the superficial palmar arch. It is superficial, covered only by the skin, superficial and palmar fascia, and near the ulnar border of the hand by the palmaris brevis muscle.

An incision of an inch and a half in length is to be made in the direction of the artery, and about three lines to the radial side of the pisiform bone. The skin, fatty superficial fascia and palmaris muscle being divided, the palmar aponeurosis is to be raised and incised on a director. The radial margin of the wound is to be held outwards with a blunt hook, and some dense masses of adipose tissue covering the artery, are to be drawn out and clipped away with the scissors. The vessel is then seen below, and is to be isolated from its veins and tied. This process is little used.

LIGATURE OF THE ANTERIOR INTEROSSEAL IN THE LOWER HALF OF ITS COURSE. (PL. XIII.) (*Process of the Author.*)

Operation.—An incision two and a half to three inches long is to be commenced about the junction of the outer with the middle

third of the arm, and carried downwards in the direction of the styloid process of the ulna. The skin and fascia being divided, we fall into the line of separation between the superficial and deep-seated flexors, the latter of which will be known by the *tendinous matter* on its front surface. The space between these muscles is to be separated with the finger, which should be worked down in the direction of the inner edge of the radius, until the interosseous ligament is felt. The finger is then to be pressed inwards on the membrane so as to loosen and raise up the edge of the deep-seated flexor under which the artery is placed. The needle is then to be passed round the vessel from without inwards, so as to avoid the interosseous nerve, which is seen upon the edge of the muscle. After the opening of the skin and fascia, the knife is no more to be used.

ARTERIES OF THE TRUNK.

LIGATURE OF THE ABDOMINAL AORTA.

Surgical anatomy.—The abdominal aorta, after passing the diaphragm, where it is a little to the left of the middle line, gets gradually more in front of the vertebral column, and divides into its two primitive iliac branches at the lower border of the fourth lumbar vertebra. The lower portion of the aorta, or that between the transverse part of the duodenum and its bifurcation, is the only one which particularly interests the surgeon; the upper division of this portion, from the facility with which, in the neighbourhood of the umbilicus, we may by strong compression arrest the flow of blood down the vessel, and thus temporarily check hemorrhage from the arteries within the cavity of the pelvis; and its lower division, that, immediately above the origin of the inferior mesenteric, half an inch to an inch or more in length, in consequence of the *possibility* of applying a ligature upon it in aneurism or wound of the primitive iliaes. On the right side the aorta is flanked by the ascending vena cava, and on the left by the psoas muscle; it is covered directly in front, in common with that vein, by an aponeurotic sheath, in which are lodged numerous branches of the sympathetic nerve, a chain of lymphatic glands, and in front of these a layer derived from the posterior parietal peritoneum. The distance of the artery from the abdominal integuments will vary in proportion to the thinness or obesity of the subject; but on the average will be found to be between three and four inches, covered only by the walls of the abdomen and the mass of small intestines.

Anastomosis.—There are several anastomosing vessels, by which the circulation of the blood *might be restored* to the lower extremities, a result which has many times been found attendant on accidental obliteration of the aorta in man, and its experimental ligature in dogs. The most important of these are the internal mammary, which anastomoses with the epigastric; the lumbar and interosseals, which are connected at their extremities with the ileo-lumbar and circumflexa ilii: and when the ligature is placed, as is considered most advisable, above the origin of the inferior mesenteric, the blood might be restored to the leg through the agency of this latter artery, which is more or less directly in communication through the hemorrhoidal with most of the branches

that go out from the pelvis, and is united above to the superior mesenteric by some very large anastomosing branches.

Remarks.—Since the attention of surgeons has been called to this subject, more than forty cases have been reported of contraction or accidental obliteration of the aorta from the pressure of tumours or other causes, all of which tend to prove the possibility, as before observed, of a return of the circulation to the lower extremities after the obliteration of the lumbar portion of this vessel. Upon these facts, in cases admitting of no other chances of relief, has been founded the hope of success in cutting down upon and tying this important trunk, rather than upon the results of experiments on dogs, whose tenacity of life surpasses that of man. In the three cases in which it has been tied in the living subject, the issue did not justify the boldness of the proceeding, and it is very questionable whether any case could occur that would fully sanction the step. Apart from the great size of the vessel, we run the risk of finding it diseased in aneurism of the primitive iliac, and of many of the collateral vessels being obliterated by the tumour. If there be wound of the iliac arteries of much size, time would not be afforded for the operation; and if it be a puncture, merely, the surgeon could not satisfy himself sufficiently well in regard to the origin of the hemorrhage to justify the tying of the aortic trunk. Gangrene, from want of a return of the circulation to the lower extremities, peritonitis and hemorrhage, are the accidents to be apprehended in ligature of the aorta. The first operation of this kind was done by Sir A. Cooper in 1817, and his patient died at the end of forty hours. Mr. James, of Exeter, operated in 1829, and the patient sunk three hours after. Mr. Murray performed a similar operation at the Cape of Good Hope in 1834, and his patient died at the end of twenty-three hours.

Operation. (Process of Sir A. Cooper.)—The patient laid upon his back, with his thighs and head flexed upon the trunk, an incision three inches in length is made on the left side of the umbilicus in the direction of the linea alba. A slight curvature is given to the line, in order to avoid the umbilicus, which should be just opposite the centre of the incision. The linea alba is to be cut through, and, an aperture being made in the peritoneum behind it, the finger is to be introduced, and that membrane divided with a probe-pointed bistoury to the extent of the external wound. Gliding the fore finger down upon the spine, pushing to one side the intestinal convolutions, the pulsations of the aorta are readily felt. With the finger nail an opening is to be scratched in the peritoneum and aponeurotic layer immediately upon the left side of the vessel. The finger is then to be passed between it and the spine, and brought out on the right side between it and the vena cava. The finger serving as a conductor, the ligature is carried by a blunt needle under the vessel, and tied in the usual manner, care being taken at the same time to keep the noose clear of the intestines. The wound in the parietes is to be closed with the quilled suture and adhesive straps. One end of the ligature is to be removed with the scissors, the other secured on the left side of the wound. Sir A. Cooper tied the vessel three quarters of an inch above its bifurcation and below the origin of the inferior mesenteric, and in this he was followed in the two other cases above noticed in which it was tied. It has been proposed, instead of opening the peritoneum, to incise the walls of the ab-

down on the left flank, and push off the serous membrane with the fingers till the artery could be reached.

LIGATURE OF THE ILIAC ARTERIES.

Surgical anatomy.—The primitive iliac arteries are formed by the bifurcation of the aorta. They diverge from each other, and running obliquely downwards and outwards, each divides opposite, or nearly so, to the sacro-iliac symphysis, into the internal and external iliaes. The average length of the common or primitive iliac arteries is about two inches and a half. The relation of the arteries of the two sides is, however, different. Each of the common iliaes has in front of it the peritoneum, and is crossed near its bifurcation by the ureter, by the spermatic vessels and nerves, and has the psoas muscle to its outer side. The right crosses in front of the left common iliac vein, and rests upon its own corresponding venous trunk. The left common iliac artery is crossed in addition by the branches of the inferior mesenteric artery, which descend into the pelvis; its vein is below and slightly to its inner side. Neither iliac artery gives off branches previous to its bifurcation.

The *internal iliac* artery in the adult is a short, stout trunk, about an inch and a half long. It is directed almost perpendicularly downwards and inwards, from the sacro-iliac symphysis to the upper part of the sacro-sciatic notch, where it divides into several branches. The vein which accompanies it lies on its outer and posterior surface.

The *external iliac* is apparently the continuation of the primitive trunk, as both are placed at the inner side of the psoas muscle; and in the unopened abdomen a line drawn from the umbilicus to Poupart's ligament a half an inch internal to its centre, will be found directly over both of these vessels. The external iliac artery has its vein lying on its inner side; on its outer are two or three small branches from the lumbar plexus of nerves, and beyond these again to the outer side of the psoas muscle lies the anterior crural nerve. Near Poupart's ligament it crosses in front of the psoas, and, emerging upon the thigh below that ligament, takes the name of femoral. Near this point of emergence it is crossed by the spermatic vessels, by the circumflexa ili vein, and by the vas deferens, which, on turning down into the pelvis, touches its inner side. Above the ligament it gives off the epigastric and circumflex iliac arteries. It, as well as the primitive and internal iliac, is covered in front with peritoneum and some very loose subserous cellular tissue. On the right side it is crossed by the small intestines as they go to terminate in the cæcum, and on the left has in front of it the sigmoid flexure of the colon.

Anomalies.—In reference to these great arterial trunks, anomalies as to origin or distribution are exceedingly rare. In some few instances the external iliac has been known to come off directly from the aorta.

Anastomosis.—After the ligature of the primitive, the internal or the external iliac of one side, the intimate union which exists between the branches of the vessels of the two sides, (apart from the arterial communications mentioned in reference to tying the aorta,) renders easy the re-establishment of the circulation in the parts below. In cases of aneurism within the cavity of the pelvis, it is possible, especially if the tumour be large and of long stand-

ing, that some of these branches may have been obliterated by pressure, so as to present an obstacle to the return of the blood.

Remarks.—The successful results that have many times attended the ligature of these large and important vessels, may be looked on as among the most important achievements in modern surgery. In an anatomical and physiological point of view, the issue in these operations might well have been expected to be more favourable than in those for the obliteration of the arteries which emerge from the aorta at the root of the neck. For the iliac vessels can be reached without the division of any important nerves or blood-vessels; the peritoneum covering them is so happily provided with loose flocculent cellular tissue on its outer face, as to be readily pressed off from them without itself receiving necessarily any serious injury; and the vessels themselves are intended in a great degree to supply merely the organs for locomotion. While in regard to those of the neck the immediate proximity of the vessels to the heart; the vitally important parts which are necessarily more or less disturbed in the operation: the distress of the great organs of circulation and respiration on the one hand from the sudden stoppage of a large and direct outlet of the blood, and that of the brain on the other, which may suffer either by the increase, diminution or irregularity in the amount which it receives; and the singular discrepancy existing in reference to the place of origin of their anastomosing branches, serve to explain the difference as to the result which attends the ligature of the great arteries, at the two opposite extremities of the trunk.

Of ligature of the external iliac, practised mainly for inguinal aneurism, about sixty cases have been collected. Of these, two-thirds have been cured, and not more than three have resulted fatally in consequence of gangrene of the lower extremity. The deep situation of the internal iliac protects it against traumatic injury, and the shortness of the trunk itself does not allow space sufficient to act upon it, in case it should be affected by aneurism—an occurrence so exceedingly rare, that as yet the instance reported by Sandifort may be considered the only one well authenticated. It has been tied in several cases for aneurism of the gluteal artery. Mr. Stephens, of Santa Cruz, tied it in 1812 with success; Mr. Atkinson, of York (England), in 1817, but death followed at the end of twenty days. In four other instances it has been tied with success—by Dr. S. P. White, of Hudson, New York, by Mr. Thomas, of Barbadoes, by a Russian army surgeon, and by Professor Mott.

The primitive iliac has been many times tied; by Professor Gibson, of this city, in 1812, in a case of severe gunshot wound, from which, rather than from the operation, the patient died thirteen days after; successfully by Professor Mott, of New-York, in 1827; and in 1828, with a less happy result, by Sir Philip Crampton. It has also been tied by Syme, Guthrie, Salomon, and other operators; and recently with perfect success, so far as the operator was concerned, by Dr. Edward Peace, of this city.* The patient of Dr. Peace, however, after he had recovered so as to engage in his usual labour for more than twelve months, had a return of the disease in the portion of the sac below Poupart's ligament. This sac was supplied by the anastomosing vessels which entered into

* Vide Amer. Journ. of Med. Sciences for April, 1843.

the external iliac near Poupart's ligament, and did not pulsate. It finally ulcerated and burst. As the upper lumbar arteries were concerned in the anastomotic circuit of the blood, pressure on the trunk of the aorta did not arrest the hemorrhage, and therefore rendered a resort to the ligature of the main trunk, injudicious. On an autopsic examination the primitive and external iliac of the diseased side were found completely obliterated.

LIGATURE OF THE INTERNAL ILIAC. (PL. XV.)

Operation.—The patient is to be placed on his back, with the thighs and trunks slightly flexed in order to relax the muscles of the abdomen. The surgeon stands by the side of the patient with his face towards the pelvis, (if he operate upon the right side,) and makes an incision in the manner of Mr. Stevens, of about five inches in length, slightly convex outwards, commencing about half an inch to the outer side of the external abdominal ring, and an inch above the ligament of Poupart, so as to avoid injury to the spermatic cord. The incision is to be nearly parallel with the course of the epigastric artery, but a half to three quarters of an inch at its outer side, and inclined more outwardly above to a point, fifteen lines above and as much to the inner side of the anterior superior spinous process of the ilium. If the operation be on the left side, I find it more convenient to stand with the face fronting the patient, as it leaves the left hand at liberty to

support the abdominal parietes and subsequently press inwards the peritoneum and the parts which it contains. In this case the external incision may be made from above downwards. The integuments, superficial fascia, and the three layers of muscles, may be divided by successive strokes with the knife, from above downwards, or cut from within outwards on the grooved director. Some branches of the superficial epigastric and circumflexa ilii arteries may require to be tied. The fascia transversalis is now to be opened with the finger nail, or by a cautious use of the knife, and the orifice enlarged upwards and downwards on the director. This membrane will be found more resisting at the upper part, than near the ligament of Poupart. The peritoneum is then to be carefully separated on its outer face with the index finger, and drawn by a blunt hook, with the intestines which it loosely invests, towards the linea alba. With the left index finger we continue the separation of the peritoneum towards the sacro-vertebral articulation, following the movement with the thumb and fore finger of the right hand, till they reach the vessels. The external iliac artery will be first felt or seen; trace this up to the bifurcation, where, below and within, we find the artery in question, nearly opposite the centre of a line drawn from the anterior superior spinous process of the ilium to the umbilicus. The artery is then to be isolated on its inner side with the left fore finger, and on its outer side with the right; and either hooked up on the left fore finger, or grasped between the thumb and index finger of the right hand.

PLATE XV.—LIGATURE OF THE ARTERIES OF THE TRUNK.

The subject from which this drawing was taken is represented as laid on the back, in order to contrast the operation of the two sides.

INTERNAL ILIAC. (*Right side.*)

- (A A). Division of the skin and abdominal muscles.
- (B). Psoas magnus muscle.
- (C). Sac of the peritoneum, detached with the finger and carried inwards with the eye speculum. The bulging of it at the upper part of the wound is made by a loop of small intestine within the sac.
- (D). Ureter, crossing the internal iliac artery from above inwards and downwards.
- (E). Fascia transversalis laid open.
 1. Common or primitive iliac artery.
 2. External iliac artery, the margin of which only, is shown under the spermatic vessels.
 3. Internal iliac raised on the point of the aneurismal needle, and dragged farther forwards (in order to give a clear view of its position) than would be proper on the living subject.
 4. Spermatic vessels.
 5. Internal iliac vein, deeply placed.
 6. Branch of lumbar plexus of nerves. The same process as shown on the drawing would suffice for ligature of the primitive iliac.

LIGATURE OF THE EXTERNAL ILIAC NEAR ITS ORIGIN. (*Left side.*)

- (A). Division of the tendon of the external oblique muscle of the abdomen.
- (B). Cut edge of the internal oblique muscle.
- (C). Lower border of the transversalis muscle, sending an investment down over the spermatic cord (D).
- (E). Fascia transversalis, in which is formed the internal abdominal ring; the ring being enlarged in this case to get at the artery below.
 1. Internal iliac artery and vein, the vein lying to the inner side.
 2. Epigastric artery and veins. The iliac artery is seen raised on the needle at the place for applying the ligature.



The ligature is next to be passed from within outwards, taking care to avoid raising the ureter and peritoneum on the inner face of the artery, or the external iliac vessels, which latter are so loosely connected as to admit of being pressed by an assistant backwards and out of the way towards the iliac fossa. The ligature may readily be carried round the vessel with the instrument of Professor Gibson, the needle of Deschamps as modified by Græfe, or with a flexible silver probe bent to the proper shape, and conducted along the back surface of the finger. In Plate XV, intended to illustrate this operation, it will be observed that the artery is more forcibly elevated in order to bring it clearly into view than would be proper on the living subject.

LIGATURE OF THE PRIMITIVE OR COMMON ILIAC. (PL. XV.)

The only difference in regard to the operation for securing this trunk, from that which has been just described, is the necessity of extending the line of incision for two or three inches higher up. The incision should also be made more vertically, as this gives a greater facility for reaching the artery, which is so deep that it may be found distant the whole length of the aneurismal needle, when the walls of the same side have been rendered prominent by an aneurism of the external iliac,—the common cause which necessitates the operation on the primitive trunk. The more the top of the incision approaches the median line, the greater, however, will be the risk of wounding the peritoneum, and the tendency of this membrane with the intestines which it contains to bulge outwards through the external wound. The risk of injury to the peritoneum (which membrane, though it has been wounded without serious consequences by Mr. Tait, it is by all means important to avoid,) may in a great measure be obviated by making the first opening in the transversalis fascia near the lower end of the wound, carefully avoiding the epigastric artery. The tendency to bulging of the intestines will be best overcome by a curved spatula, or thin flat piece of board two or three inches broad, introduced into the bottom of the wound and held by an assistant. The ureter should be raised with the peritoneum from over the vessel, and the ligature placed about half an inch above the bifurcation of the latter. By the same process, and without opening the peritoneum, the lower part of the aorta may be reached; such was the plan followed by Mr. Murray in his operation on the latter vessel already noticed.

LIGATURE OF THE EXTERNAL ILIAC. (PL. XV. AND XVI.)

This artery may readily be tied in any part of its course, but the lower third is usually selected for the operation. Aneurism at the groin is the common cause of its ligation, and as this is sometimes found with an elongated pouch extending up above Poupart's ligament, we may be compelled often to seek the artery higher up than was first intended.*

The patient is to be similarly placed as for the preceding operation. If the abdomen is flat, the pelvis may in addition be inclined to the side of the operator;—if tumid and prominent, it is to be turned in the opposite direction, so as to allow the mass of the

small intestines to fall away from the place of operation. The aorta may in this, as in the two preceding operations, be compressed at the umbilicus by an assistant; the surgeon is to stand likewise at the outer side of the pelvis. An incision, convex outwards and downwards, three to four inches long, is to be commenced just above the margin of the external abdominal ring, and carried up nearly parallel with Poupart's ligament, terminating about three quarters of an inch above and as much within the anterior superior spinous process of the ilium. After the skin the superficial fascia is to be divided; in this fascia, crossing the wound, is found the *arteria ad cutem abdominis* or superficial epigastric which may be tied and cut. The aponeurosis of the external oblique next comes into view; this may be opened from above downwards with the knife, or, which is better, cut on the grooved director the whole length of the cutaneous incision. The point of the fore finger should now be introduced at the lower end of the wound under the arch formed by the inferior border of the internal oblique and transversalis, so as to separate them from the fascia transversalis and spermatic cord. These muscles are then to be hooked up on the fore finger and divided across to the extent of half an inch with a curved probe pointed bistoury. Some small branches of the epigastric and circumflex iliac arteries will now require to be secured. The fascia transversalis is next to be opened. This should be done at the lower part of the wound by scratching it with the finger nail, or by raising a fold with the forceps and puncturing it with the knife. The finger is then to be introduced between the fascia and the peritoneum, upon which the fascia is to be further divided or torn. With the fore and middle fingers the peritoneum is next to be detached from the iliac fossa and pushed upwards. The thigh is to be now well flexed, and an assistant carrying his hand to the bottom of the wound, draws upwards and towards the opposite side the divided edge of the abdominal muscles and the bag of the peritoneum containing the mass of intestines. The spermatic cord will be left below and hardly at all brought into view, if the artery is to be tied high up. But if the artery is tied near its middle, as in Pl. XV, the cord may be at the same time raised up by the hand of the assistant. The lower or outer lip of the incision should be depressed with a blunt hook, and the artery will be found pulsating along the brim of the pelvis, covered with a thin sheath, in front of which a small nerve is observed. The sheath is to be raised in a fold with the forceps, and opened with the point of a director; the artery is to be denuded, first on its outer and then on its inner side; and the aneurismal needle carried from within outwards between it and the vein; the small nerve, as the needle emerges from below the artery, being pushed outwards with the finger so as not to be included in the loop of the ligature.

Remarks.—The direction of the external incision has been singularly varied in this operation. Abernethy cut nearly directly over the course of the vessels; this plan answers well to uncover the artery high up, but is attended with risk of injury to the peritoneum. Sir A. Cooper cut from the internal margin of the external abdominal ring to the anterior superior spinous process of the ilium, following the curve of Poupart's ligament. The processes of Norman and Velpeau (Pl. XVI) are mere modifications of that of Cooper, but do not afford the same facility for reaching the artery in the upper part of its course. Some have opened the

* See the case of Professor Horner.—*Amer. Journ. Med. Sciences*, 1842.

parts with incisions in the form of a \perp reversed, the lower line being curved; but the process which is above described in full, I have found the most convenient, as it enables us to reach the artery with great facility in any part of its rout, and exposes as little as any other to the chances of subsequent hernial protrusion. Bogros has devised a plan for securing the artery just above the ligament, which is equally well suited to ligature of the epigastric, and will be described in reference to that vessel.

LIGATURE OF THE EPIGASTRIC ARTERY. (PL. XVI.)

Arising from the outer side of the external iliac just above the crural arch, this vessel forms an elbow near its origin, and ascends between the two abdominal rings and behind the cord to the rectus muscle to the abdomen, which it reaches about an inch and three quarters above the place of its origin, and in the direction of a line drawn from this point to the umbilicus. It may be tied either at its place of entry into the rectus, or near its origin.

Ligature at its place of origin. (Process of Bogros.)—Make an oblique incision two inches long parallel with the fold of the groin and two lines above Poupart's ligament, with its two extremities equi-distant from the spine of the ilium and the pubic symphysis. The superficial fascia and aponeurosis of the external oblique are to be opened to the same extent on the director.

Draw upwards the spermatic cord, in order to discover behind it the orifice of the internal ring. Dilate this opening with the finger or director, and the epigastric will be found immediately behind and to the pubic side of its inner margin. By following the epigastric back to its origin, we fall upon the external iliac artery, which may at this point be isolated and tied by the same process. An incision at this portion of the abdominal parietes, must of course render the patient afterwards more or less liable to the development of a hernial tumour. At the point where it enters the rectus, the epigastric artery may be exposed and tied by dividing parallel to the external border of this muscle, the skin, the aponeurotic tendons of the external and internal oblique, and the lower fibres of the transversalis muscle. By drawing the muscle inwards, the artery will be exposed.

LIGATURE OF THE GLUTEAL ARTERY.

Surgical anatomy.—The gluteal artery comes off from the internal iliac. It is a short thick trunk, which escapes from the pelvis above the pyriformis muscle, close against the upper part of the great sciatic notch, near which it divides into a superficial and deep-seated branch. The superficial supplies the under surface of the gluteus maximus; the deep, which is the larger, runs between the gluteus medius and minimus. The trunk is attended

PLATE XVI.—LIGATURE OF THE EXTERNAL ILIAC AND FEMORAL ARTERIES.

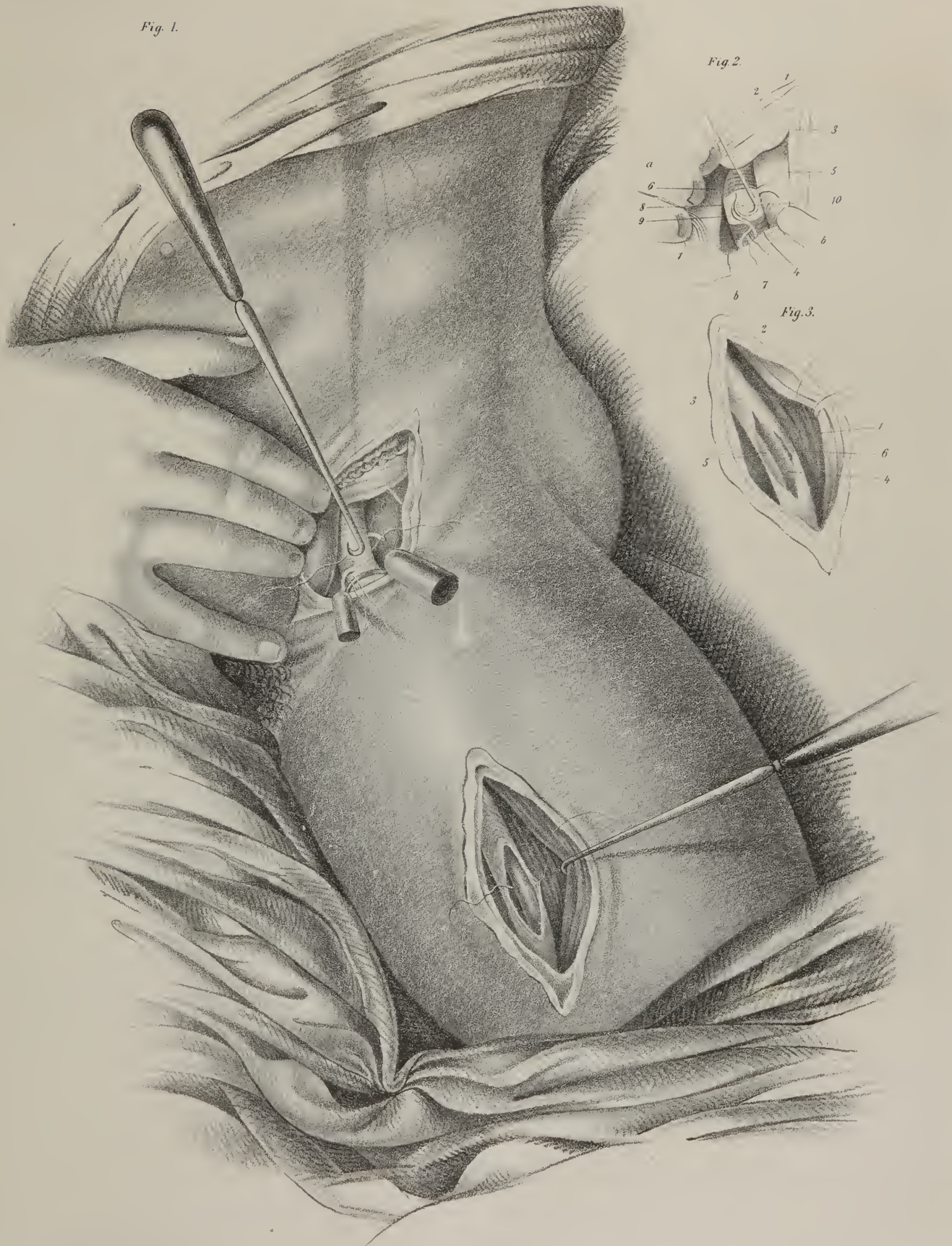
(Fig. 2.) OF THE EXTERNAL ILIAC JUST ABOVE POUPART'S LIGAMENT. (*Process of Mr. Norman as modified by Velpeau.*)

- a. The left hand of an assistant, drawing upwards and inwards the superior lip of the wound, and supporting at the same time the weight of the abdominal viscera.
- b, b. Blunt hooks, depressing the inferior lip of the wound.
 1. Line of division of the skin.
 2. Section of the three abdominal muscles.
 3. Peritoneum, covered with its subserous cellular layer.
 4. Spermatic cord, pressed downwards.
 5. Iliac fossa. The iliacus internus muscle is seen covered with its aponeurosis or fascia; below the aponeurosis is seen a branch of the lumbar plexus of nerves.
 6. External iliac vessels, inclosed in their sheath.
 7. Epigastric artery, shown at its origin. Around this vessel is passed a thread, showing the possibility of tying it at this place in case it is accidentally wounded.
 8. External iliac vein, to the inner and the posterior side of the artery.
 9. Small nerve descending with the artery, which should be carefully excluded from the ligature.
 10. External iliac artery, isolated and raised on the aneurismal needle of Græfe.

(Fig. 1.—Fig. 3.) OF THE FEMORAL ARTERY AT THE UPPER PART OF THE MIDDLE THIRD OF THE THIGH. (*Process of Hunter.*)

1. The sartorius muscle. Its inner edge is drawn outwards with a blunt hook.
2. The fascia lata, which, with the superficial fascia, is divided over the muscle nearly the whole length of the cutaneous incision.
3. Sheath of the femoral vessels, laid open near the middle part of the wound.
4. Femoral artery, raised on the ligature.
5. Femoral vein.
6. Saphenus nerve, to the outer side of the artery and involved in the sheath.

Fig. 1.



by a vein and nerve. A line drawn from the posterior and superior spine of the ilium to the middle of the space between the trochanter major and tuberosity of the ischium, crosses the vessel, which will be found at the junction of the superior with the middle third of this line. The artery is covered from without inwards, by the skin, a thick layer of dense fatty cellular tissue, the belly of the gluteus maximus, and a strong aponeurotic membrane. It rests upon the upper margin of the gluteus medius.

Remarks.—The vessel is so deeply placed that it cannot be influenced by compression. It has been four times tied in consequence of traumatic injury. In the celebrated case of John Bell, the first instance in which it was tied, it had been cut across in a punctured wound, and gave rise to an extensive tumour. A first incision was made by Mr. Bell eight inches in length. The patient came near bleeding to death, “*although in a moment twenty hands were about the tumour, and the bag was filled with sponges and clothes of all kinds.*” The operator “*then run the bistoury upwards and downwards, and at once made an incision two feet in length,*” by which he was enabled to secure the vessel. The patient barely escaped with life, and unquestionably ran a greater risk than if a ligature had been placed instead around the internal iliac. The position of the gluteal artery should be well understood by the surgeon, for Theden mentions a case in which it was divided across in dilating a gunshot wound, and the patient in consequence lost his life.

Operation. (*Process of Lizars and Harrison.*)—The patient is to lie on his belly, with the thigh extended and the toes turned inwards. An incision three to four inches long is to be begun an inch below the posterior superior spine of the ilium, and an inch to the outer side of the sacrum, and carried down obliquely toward the great trochanter, crossing the vessel. Having divided the skin and subcutaneous fatty matter at the first cut, separate in the same direction the fibres of the gluteus maximus, without cutting, if possible, as the muscle is exceedingly vascular; tear with the director or cut the aponeurosis covering the gluteus medius, and the vessel will be found covered by a loose sheath at the top of the sciatic notch. Care must be observed not to mistake the deep-seated branch for the main trunk. From the depth of the parts, the ligature must be carried round the vessel, with the curved aneurismal needle.

LIGATURE OF THE ISCHIATIC ARTERY.

Surgical anatomy.—The artery emerges from the pelvis at the lower part of the great sciatic notch, and, as shown by Lizars, nearly at the middle of a line drawn from the posterior superior spine of the ilium, to a point somewhat within the middle of the space between the trochanter major and sciatic tuberosity. The artery will be found a little in front of the great sciatic nerve, and rather more than an inch and a half below the gluteal. The two vessels have nearly the same coverings.

The ischiatic, though smaller than the gluteal, has been more frequently found aneurismal.

The operation for its ligature will differ but little from that just described. Harrison advises the incision to be made in the same direction as for the gluteal, but begun an inch and a half lower down, and looks for the vessel after having divided the same number of layers.

LIGATURE OF THE INTERNAL PUDIC.

Surgical anatomy.—This artery passes from the pelvis just below the ischiatic, and is separated from it only by a mass of fat. It winds immediately round the outer surface of the spine of the ischium, and returns into the pelvis again through the lesser sciatic notch, to place itself on the inner face of the tuberosity of the ischium. In this part of its course it is covered exteriorly by the external border of the great sacro-sciatic ligament. Posteriorly, it is covered by the gluteus maximus and the thick integuments of that region. If the subject be placed on his back, the leg extended and the toes turned inwards, the artery, as indicated by Harrison, will be found crossing the spine of the ischium at the junction of the external with the middle third of a line drawn from the summit of the trochanter major, to the base of the os coccygis; an inch and a half above the most prominent part of the sciatic tuberosity, and about two inches from the external border of the os coccygis.

Remarks.—The artery, as it winds round the spine of the ischium, may be compressed against the bone. Mr. Travers succeeded by this means in arresting an alarming hemorrhage, occasioned by a gangrenous ulcer of the glans penis, when all other measures had failed. He placed his patient on a hard bed, with two firm compresses so arranged as to press against the spine of each ischium.

Operation. (*Process of Harrison.*)—To tie this artery, an incision is to be made three inches long, extending from the outer border of the fourth sacral vertebra, in the direction of the root of the great trochanter, parallel with the fibres of the gluteus maximus. These fibres are to be well separated, or cut if necessary. We then fall upon the great sacro-sciatic ligament, the external border of which, as well as a dense fascia which comes off from it, is to be divided. The coccygeal branch of the ischiatic artery appears first. This is to be tied and cut, and should not be mistaken for the pudic, which lies deeper. With the finger, we feel for the spine of the ischium, and near the point of it, the artery in question will be found pulsating. It is to be isolated with the handle of the scalpel, and the ligature carried around it in the usual way, taking care to avoid the nerve, which lies to its inner side. The vein, which is of less importance, is covered by the artery.

The vessels given for the finding of the three last arteries must be varied somewhat according to the development of the pelvis, and as they are usually tied only in cases of wounds or traumatic aneurism, when the jet of blood directs us in a considerable degree to the vessels concerned, it has not been thought necessary to accompany them with any illustration.

LIGATURE OF THE FEMORAL ARTERY.

Surgical anatomy.—The femoral artery extends from near the middle of Poupart's ligament to the top of the inferior third of the thigh, where it passes through the opening in the tendon of the adductor magnus, to be continued down behind the knee joint under the name of popliteal. At the upper fourth of the thigh the femoral artery is placed in a triangular space; the base of this triangle is formed above by Poupart's ligament, the inner margin by the pectineus and adductor muscles, and the outer by the sartorius; the apex is found from three to four and a half inches lower where the adductor muscles are crossed by the sartorius.

In the female, owing to the greater breadth of the pelvis, the artery under Poupart's ligament is usually found about a quarter of an inch nearer the spine of the pubis than it is in the male. In the triangle above described, the artery is placed very superficially, and can be felt strongly pulsating throughout its whole extent, but more especially where it passes over the head of the os femoris. It rests near the pelvis on the tendon of the psoas, and then crosses the insertions of the pectineus and adductor brevis. It is covered in front by the integument, superficial fascia, the fascia lata, and its proper sheath over which is spread a thin cellular layer; near the ligament of Poupart, some lymphatic glands involved in the superficial fascia, and the funnel-shaped extension of the transversalis and iliac fasciæ of the pelvis, are also found above it. The femoral vein, placed at first to the inner side of the artery, gets gradually behind it as it descends. The crural nerve, as it emerges from the pelvis, is about half an inch to the outer side of the artery, and quickly divides into many branches, some of

which descend along the outer side of the sheath; and one—the saphenus major—enters the sheath at the point of this triangle, and passes along the outer and fore part of the artery down the middle third of the thigh. The most important branch which the artery gives off in this part of its course is the profunda. This arises from the posterior surface of the artery, sometimes close to the ligament, but most usually an inch and a half to two inches below it.

The artery, after leaving the apex of the triangle, becomes deeper seated, and is covered by the sartorius muscle, which crosses it very obliquely from above downwards and slightly inwards, so as to leave the artery at the termination of the middle third of the thigh, opposite the outer edge of this muscle, and between it and the vastus internus. As the sartorius muscle varies in breadth according to the muscularity of subjects, from one to two inches, the extent of the artery covered by it, will of course vary in proportion; the inner edge of the muscle meeting

PLATE XVII.—LIGATURE OF THE FEMORAL ARTERY.

ABOVE THE ORIGIN OF THE PROFUNDA.

Fig. 1 and Fig. 2.—The leg is flexed and the limb rests upon its outer side. The patient lies on the back with the trunk a little inclined to the side of the operator.

1. Line of division of the skin.
2. Incision in the fascia superficialis, which is very thick at this point.
3. Lymphatic ganglion, drawn out of the way of the knife.
4. Superficial artery cut across, which is to be tied or twisted.
5. Incision of the sheath of the femoral vessels, formed from the iliac and transversalis fasciæ.
6. Femoral vein lying within and behind the artery.
7. Incision in the proper sheath of the vessels, made directly over the artery.
8. Femoral artery, raised on the aneurismal needle.

AT THE UPPER THIRD OF THE THIGH. (*Process of Scarpa and Hodgson.*)

Fig. 1 and Fig. 3 (A). Right hand of the operator holding the grooved director.

(B). Left hand of the operator. The first two fingers draw outwards the external lip of the wound and the sartorius muscle—the nail of the fore finger guiding the beak of the director.

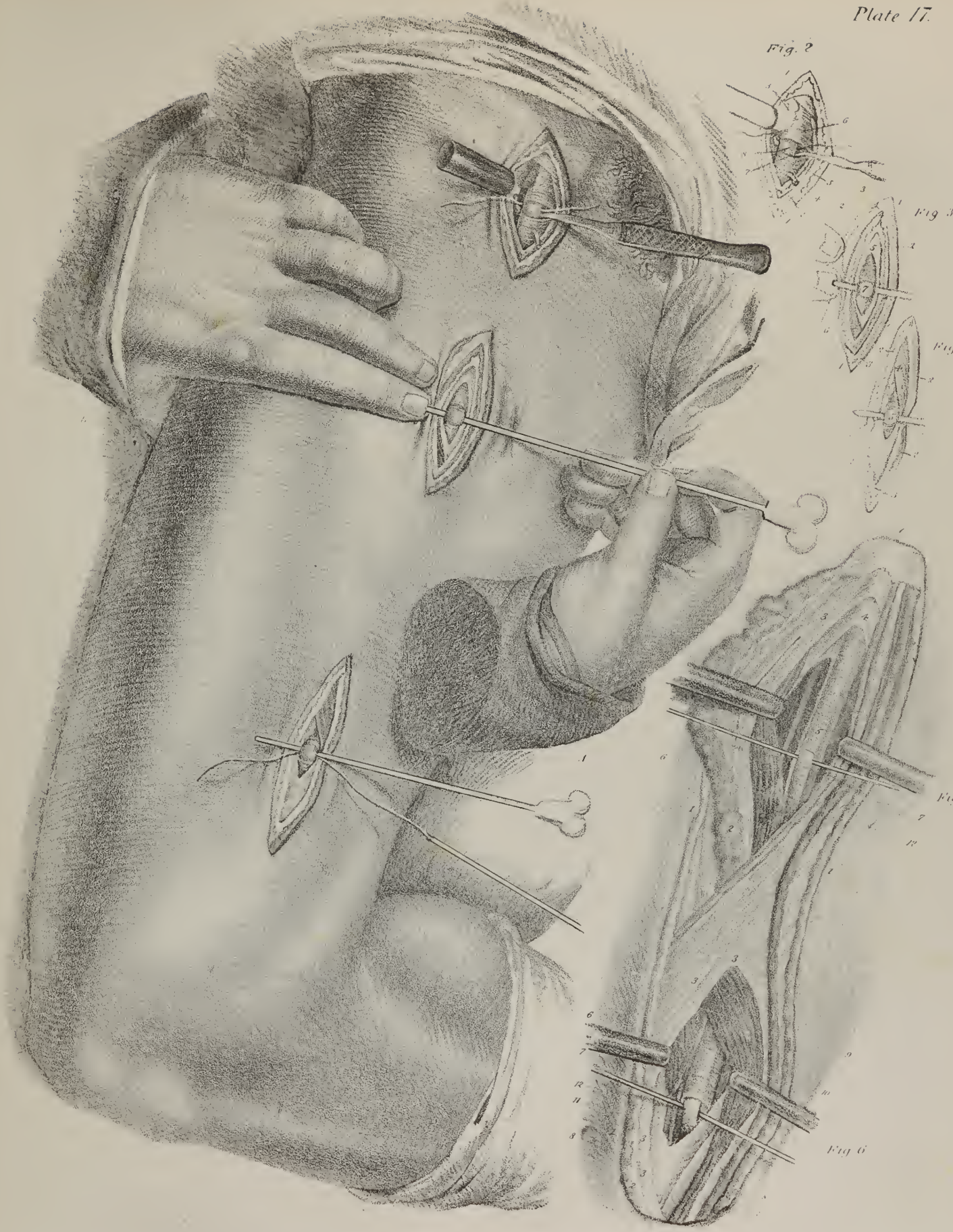
1. Incision of the skin.
2. Division of the fascia superficialis.
3. Division of the fascia lata.
4. Division of a layer which comes from the edge of the sartorius.
5. Incision in the sheath of the vessels.
6. Inner edge of the sartorius muscle.
7. Artery denuded and raised on the director.

AT THE LOWER THIRD OF THE THIGH. (*Process of Hutchinson and Roux.*)

Fig. 1 and Fig. 4.—The incision is here made so as to fall upon the artery on the outer side of the sartorius.

2. Incision of the skin and superficial fascia.
3. Longitudinal division of the fascia lata.
4. Anterior or outer margin of the sartorius muscle, which, in this operation, is to be pressed downward and inward by an assistant so as to expose the artery.
5. Opening made in the sheath of the vessels, through which the artery is seen raised on the grooved director. The ligature is shown as just passed along the groove on an eyed probe.

Fig. 5. *Anatomical relations of the artery in its course down the thigh. This drawing is designed to illustrate the operation at the upper and lower third of the thigh.*



the vessel at a distance varying from two to four inches below the ligament. Below the muscle is found a firm fascia covering the artery, extending from the vastus internus to the adductors. The artery as it descends into the ham, is at the inner side of the thigh bone and passes through a long fibrous channel in the tendon of the adductor magnus, which in the operation at this point may be slit open on its upper surface, so as to expose still more of the course of the artery on the front of the limb. The line of the vessel from the pelvis to the knee joint, will be marked with a string drawn from near the middle of Poupart's ligament to the middle of the popliteal region, turning obliquely round the inner face of the thigh. The great saphena vein is imbedded in the superficial fascia, and opens into the femoral about two inches below Poupart's ligament. It is found in a line between its place of termination and the back of the internal condyle. Traced upward from the condyle, it is found first at the anterior or outer margin of the sartorius; crossing this muscle obliquely as it ascends, it gets to its inner or pubic margin about six inches below the ligament of Poupart, and then continues by the side of the muscle for three inches, when it leaves it to proceed direct to the femoral vein.

Anastomosis.—The femoral artery is subject to few anomalies. When it is tied below the ligament, and above the origin of the profunda, the circulation is re-established in the limb chiefly by the branches of the gluteal, ischiatic, internal pudic, and obturator, which anastomose with the branches belonging to the thigh. In cases where the artery is tied *below* the origin of the profunda,—the great muscular artery of the thigh,—the circulation in the leg is scarcely at all interrupted, the blood finding its way down through the inter-connections of the perforating and anastomotic arteries of the thigh with the several articular arteries of the knee joint.

Remarks.—The artery may be tied in any part of the course described. 1. Above the origin of the profunda, the place at which it was tied by Larrey previous to amputation at the hip joint. A serious objection to the operation at this region, is the frequent high origin of the profunda, and the danger of second-

ary hemorrhage from the speedy return of blood through the anastomosing branches so as to fill the artery below the place of ligature. 2. After the manner of Scarpa, in the triangular space at the superior fourth of the thigh, above the point at which the artery is crossed by the sartorius muscle. The artery is here more readily secured than at any other point, but the proximity of the profunda, the origin of which is sometimes four inches from the crural arch, would render less certain the formation of a solid coagulum. 3. Under the sartorius, or in the middle part of the thigh, according to the process of Hunter. In this region, although the artery is a little more difficult to uncover, there is no large trunk given off near to prevent the formation of a coagulum, and success may be considered almost certain. 4. At the outer side of the sartorius, below the middle third of the thigh, or more properly speaking, at the junction of the superior three-fourths with the inferior fourth of the thigh, where the artery is lodged in the sheath formed by the tendon of the adductor magnus. The artery is now never tied in the position last noticed, unless there exists some special reason for it, such as a wound of the part involving the artery, or the existence of a tumour or other affection in the middle and upper part of the thigh. Another objection besides the depth at which the artery is placed, is to be found in the fact that there is no depending opening, and when matter forms it is apt to spread through the surrounding cellular tissue by infiltration. It has been customary with some surgeons to tie the artery at this point, in secondary hemorrhage from the surface of the stump after the high amputation of the leg; but there is no well-founded reason for operating at this point under such circumstances, rather than at a place higher up where the artery is more accessible.

Hodgson has proposed to open the parts so as to tie the artery about five inches below Poupart's ligament, at a point intermediate to those selected by Scarpa and Hunter. The artery is here very readily reached—the inner edge of the sartorius only requiring to be raised, and if matter forms it finds a ready outlet. To this plan of Hodgson, I have usually given the preference in prac-

AT THE UPPER THIRD.

- 1, 2, 3, 4, 5, 6, 7 indicate the same parts as in fig. 3.
8. Internal saphena vein.
9. Principal bundle of lymphatic vessels, drawn to one side with the fascia lata.
10. Femoral vein.
11. Crural nerve.
12. Saphenus nerve attending the artery.

AT THE LOWER THIRD.

- 1, 2, 3, 4, 5 indicate the same parts as in fig. 4.
6. Tendinous margin of the vastus internus, serving as a guide in finding the vessels, which are placed more deeply.
7. Tendon of the gracilis muscle.
8. Falciform aponeurotic expansion of the abductor longus and magnus muscles, forming the fibrous canal for the vessels as they pass to the popliteal region, which it is necessary to lay open in order to reach the artery at this point.
9. Internal saphena vein.
10. Femoral vein.
11. Crural nerve.
12. Saphenus nerve attending the artery.

ticc. I have repeated the operation by this process for the fourth time for the cure of popliteal aneurism, and in each instance with perfect success, the wound uniting almost entirely by first intention.

The ligature of the femoral artery is called for in wounds involving this vessel, in popliteal aneurism, and in cases of disease or injury of the large arteries of the leg, when the vessel immediately affected cannot be tied with sufficient chance of success. On the femoral artery, Hunter first employed his celebrated principle for the cure of aneurism without opening the sac, by applying a ligature on the cardiac side and at a considerable distance from the tumour. Anel and Guillemeau had previously tied the artery just above and without the opening of the tumour; but the important surgical axiom, in cases of *spontaneous* aneurism, of tying the artery at a distance from the tumour in order that the ligature may embrace a healthy structure, is derived from Mr. Hunter. In cases of popliteal aneurism, the great freedom of anastomosis between the upper part of the thigh and the ham frequently allows a return of pulsation in the tumour before its contents are absorbed, without interrupting the cure.*

1. *Ligature above the profunda or at the crural arch.*

Operation.—The patient is to lie on his back, with the pelvis slightly elevated. The surgeon standing on the outer side of the limb, makes an incision downwards from the middle of Poupart's ligament for two or three inches directly over the course of the vessel. The several layers of the superficial fascia are to be cautiously divided, separating with the point of the director, the superficial arteries, veins and lymphatic glands. We come then upon the funnel-shaped sheath of the vessels, formed by the descending fasciæ of the pelvis. This is to be opened in front of the artery on a director. The *proper sheath* of the vessels, which is here loose and cellular, then presents itself, and may be divided with the point of the forceps or director. The artery is now in view. The vein lays to its inner side, and if the operation be neatly done, may not at all be seen. The curved director is to be passed from within outwards between the artery and vein, while the surgeon with his left fore finger depresses the crural nerve at the outer side so that it shall not be included in the loop. If the lymphatic glands of the region be much enlarged, the simple operation above described becomes one of greater difficulty.

2. *Ligature at the upper fourth of the thigh and below the origin of the profunda.* (Process of Scarpa, Pl. XVII.)

Operation.—It is at the inferior angle of the triangle, described at page 33, that the artery is to be tied. The operator follows

* A plan of treating aneurism by making intermittent pressure upon the artery at the Hunterian site, without incision, has been lately adopted by several of the British surgeons, and it is said with considerable success. By means of a compressor (see p. 32) a moderate degree of pressure is made over the healthy vessel. When this becomes painful, with throbbing at the part and swelling and numbness of the limb, the pressure is slackened or altogether removed; but resumed again as soon as the parts have recovered. This process is to be repeated again and again till the circulation in the artery leading to the aneurism is so far moderated as to allow the blood to become solidified in the tumour. A bandage during the treatment should be wound from the end of the limb upwards, to prevent œdema and passive congestion. Further experience is yet wanting to test the proper value of this measure, which is necessarily much more tedious and painful than the plan by ligature.

with his finger the course of the artery. At the point where the pulsation ceases to be obvious, the artery is covered by the sartorius. Commencing three fingers' breadth below the fold of the groin, an incision three inches long is to be made over the course of the artery, crossing the point at which it gets below the sartorius. The great saphena vein, lodged in the superficial fascia, will be found just at the inner side of the incision; and, if it comes into view, must be carried inwards. The superficial fascia is to be raised and cut on the director. Below this is a layer of cellular tissue intermixed with lymphatic glands and absorbent vessels. Open this with the point of the director the whole extent of the wound, using the knife merely to touch with the edge any resisting band. The fascia lata, distinguished by its density and yellow colour, now comes into view. This is to be carefully punctured, raised, and divided on the director for about half the extent of the outer wound. The vessels are now exposed, and the artery is to be isolated, and the director or aneurismal needle passed from within outward. In the method of Hodgson above referred to, the incision is made an inch lower on the thigh, and the inner edge of the sartorius drawn outwards with the finger of an assistant, so as to uncover the vessel below. In other respects, the operation of Hodgson is much the same as that just described.

3. *Ligature in the middle third of the thigh, or under the sartorius.* (Process of Hunter.)

This middle region of the thigh, as usually described, is of considerable extent. The sartorius muscle, as has already been shown, passes from without inwards, winds downward round the thigh, and crosses the artery diagonally so as to cover it for five or six inches. At the upper part of this middle third, the artery lies near the inner edge of this muscle, and may easily be exposed, as in Hunter's operation, by drawing the muscle outwards. At the central part, it is behind the middle of the muscle, and it has been proposed by Desault, in cases of operation at this point, to split the muscle longitudinally, or divide it across in case its contraction interfered with the exposure of the vessel; but in this he has had few supporters. At the lower portion, the centre of the muscle gets so much to the inner and posterior side of the vessel, that it is most convenient, in case the operation be performed at this point, to follow the methods of Hutchinson and Roux, and cut upon the outer side of the muscle and draw it inwards and downwards. A leading objection to the latter mode of proceeding, is the depth of the groove in which the artery is placed, and the mischance to which the operator is liable of opening by mistake some of the interstices between the fasciculi of the vastus internus, instead of merely widening the interval between this muscle and the sartorius.

In regard to its surgical effect, the tying of the artery in any part of this middle region is much the same; but in an anatomical point of view, it is decidedly the most advantageous, for the reasons stated, to secure it after the manner of Hunter as given below, or that of Hodgson, unless there should be some special objection, as the existence of an ulcer or tumour at the place of operation.

Operation. (Process of Hunter modified by Lisfranc, Pl. XVI.)—The patient is to be placed so that the thigh rests on its external side, slightly flexed on the pelvis, and the leg half bent on the thigh. Two assistants steady the limb, one of whom in addition

compresses the artery over the pubis with his thumb. The operator, depressing with the fingers of the left hand the oblique groove between the internal border of the sartorius and the adductor longus, divides the skin merely, for three inches, in a direction a little diagonal to this line, terminating above, half an inch within the inner edge of the sartorius, and below upon that muscle at the same distance from its inner border. The saphena vein, or one of its accessory branches, will be seen running parallel with or crossing more or less the direction of the wound, and is to be drawn inwards out of the way. The superficial fascia, and a process of the fascia lata which is attached to the margin of the sartorius and keeps it drawn inwards, may be raised separately or together on the grooved director, and divided the whole length of the wound. The inner margin of the muscle is to be denuded with a few sweeps of the finger, and drawn outwards with a blunt hook. Below we find the vessels in their sheath, the artery in front and the vein behind. Raise a fold of the sheath with the forceps and tear it, or lay it carefully open with the knife for the space of an inch. Still holding on to the sheath with the forceps, denude the artery on either side with the director, and glide it below from within outwards. If the sartorius is directed inwards so as to cover the artery to a greater extent than usual, the wound may be enlarged at its upper part, to allow us to come more readily upon the vessel.

4. *Ligature at the inferior third of the thigh as the artery passes through the sheath formed by the tendon of the adductor magnus. (Process of Hutchinson and Roux, Pl. XVII.)*

The limb is to be placed in the position just described. The operator places the ends of the fingers of the left hand in the groove between the outer border of the sartorius and the inner edge of the vastus internus. If the limb be loaded with fat, it is possible that we may not be able to discover this groove, and the artery lies too deep to enable us to distinguish it by its pulsations. We then cut in the line of direction of the vessels. An incision should be made of about four inches in extent, the centre of which should correspond with the junction of the middle with the inferior third of the thigh. The skin and superficial fascia being cut, we feel for the outer edge of the sartorius; the layer of fascia lata connected with the external border of this muscle is to be divided the whole length of the wound; and the muscle loosened in its sheath with the fore finger drawn inwards and backwards by an assistant. The posterior part of the sheath of this muscle is next to be freely opened *near its middle*, so as to prevent our falling between the loose fasciculi of the vastus. The groove between the two muscles is now exposed, at the bottom of which we find the vessels as they are about to pass into the tendinous canal of the adductor, which, when the wound has been well cleaned with the sponge, is distinguished at the lower part of the incision, by its density and pearly hue. Under the sharp edge which it presents above we glide a grooved director, and with a bistoury lay open the canal. The sheath of the vessels is now fully exposed; the nerve lying to the outer side and a little in front, the vein within and behind, and the artery in the middle. The sheath is to be opened, and the curved director or aneurismal needle passed under the artery from within outwards, as in the operation last described.

LIGATURE OF THE POPLITEAL ARTERY.

Surgical anatomy.—This artery is extended from the tendinous sheath of the adductor to about five fingers' breadth below the articulation of the knee joint, where, under the fibrous arch of the soleus it divides into the anterior and posterior tibial vessels. It runs somewhat obliquely from above downwards and from within outwards, and occupies very nearly the middle of the lozenge-shaped cavity of the ham, formed by the divergence of the inner and outer hamstring tendons above, and the two bellies of the gastrocnemius externus below. Placed first upon the os femoris, it then passes deeply between the condyles and over the popliteus muscle. In this last position it is found on the average an inch to an inch and a quarter below the surface. The popliteal vein is placed more superficial than the artery, though closely connected with it, and crosses diagonally over it, so as to be found external above, posterior in the middle, and internal to it in the lower part of this region. Between the vein and the skin passes downwards the popliteal division of the great sciatic nerve, and more superficial still is the external saphena vein, often accompanied by another smaller, which comes up from the outer margin of the tendo achillis and opens into the popliteal just above the condyles of the os femoris. The peroneal nerve runs down, sunk under the edge of the biceps flexor tendon, and gets on the outer margin of the external head of the gastrocnemius, where it turns over the fibula just below its head. All these parts are more or less imbedded in fat and cellular substance, and have as their covering, besides the skin and superficial fascia, a strong aponeurotic layer, which is an extension of the fascia lata. There are several lymphatic glands placed in the neighbourhood of the artery, and mostly above the joint. One is found superficial to the artery; and this, when enlarged and moved by the pulsation of the vessel below, has occasionally been mistaken for an incipient aneurismal tumour.

Remarks.—The popliteal artery may be tied in any part of its course, by opening, in the middle line, the lozenge-shaped cavity of the ham; but it is better, in order to avoid the popliteal vein, to tie it at the superior angle, before the artery gives off its articular branches, or at the lower end between the heads of the gastrocnemius and below the entrance of the saphena. The artery may also be reached and tied by a lateral incision under one of the heads of the gastrocnemius, where it comes nearest to the surface. Hardly any occasion could occur that would render it necessary to tie the artery between the condyles, a situation in which it is deeply placed, and lodged over the posterior ligament of the joint. The great extent and depth of the popliteal space afford room for the development of aneurismal tumours, which occur here more frequently than in any other part of the body, and sometimes attain to a considerable size before they become prominent in the ham. Prior to the time of Hunter the operation for their cure consisted in applying a ligature above and below the tumour, after the plan of Keysler, laying it open afterwards and turning out the clot. This dangerous and painful method is now completely supplanted by the Hunterian operation, in which the femoral only is tied. Even in punctured wounds of the popliteal artery, it will in a great majority of cases be best not to open this space, but to secure the femoral artery in the middle third of the thigh, inasmuch as operations in the popliteal region are apt to lead to

burrowing abscesses under the hamstring tendons which not unfrequently involve the posterior ligament of the joint. A wound of this description, attended with pressure on the articular branches from effused blood, may, however, occur, in which it would be better to dilate the opening and secure the vessel, at or near the place of injury; and it is barely possible that an aneurismal tumour may be formed, so fed with blood from the enlarged anastomosing branches, that no means will suffice for its cure short of ligature of the popliteal artery immediately above and below the tumour.

1. *Usual process for ligature of the upper part of the popliteal, by which this artery may be tied at any part of its course.* (Pl. XVIII. fig. 1.)

Operation.—The patient is to be placed on his abdomen, with the thigh and leg moderately extended and sustained by two assistants, the operator standing upon the outer side. If there be any aneurismal tumour, a tourniquet must be applied upon the upper part of the thigh. The ends of the fingers of the left hand placed in a line are to be sunk into the depression just over the outer border of the middle line of the popliteal space, and along their inner edge an incision of three to four inches in length is to be made from below upwards on the right side, and from above downwards on the left, the upper termination of which is to be opposite the superior angle of the space indicated by the separation of the biceps and semi-tendinosus tendons. If the intention is to tie the artery below the joint, the incision need not extend so high by an inch. The line of incision should be somewhat nearer the inner than the outer hamstring, and at its lower end

be directed slightly outwards on account of the greater size of the internal head of the gastrocnemius. It should cross somewhat diagonally over the course of the artery. After the division of the skin, the external saphena vein is to be drawn slightly outwards, and the superficial and deep-seated fasciæ divided the whole length of the wound on a grooved director. Open then the fatty cellular tissue that comes into view with the point of the director, relax the muscle by slightly flexing the leg, and have the margins of the wound well separated with blunt hooks. The popliteal nerve may now be seen at the external side of the artery and should be drawn outwards; the curve formed by the saphena vein as it throws itself into the popliteal is to be traced; and half an inch above and behind this curve we will find the artery, with the vein behind and at its outer side. The sheath of the vessels is to be carefully opened, the artery denuded upon either side, and a bent director or the common aneurismal needle passed below it from within outwards, the vein at the same moment being pressed downwards and outwards with the left fore finger. If the first incision is prolonged downwards between the heads of the gastrocnemius, the artery may with great facility be tied in the inferior part of its course after the manner of Lisfranc. If it be extended so low as the fibrous arch of the soleus before spoken of, we may at will tie either the anterior or posterior tibial arteries near their place of origin.

2. *Ligature of the popliteal artery, by incision upon the inner side of the ham.* (*Process of Marshal.* Pl. XVIII. fig. 11.)

The object of this method is to reach the inferior part of the artery under the tibial margin of the gastrocnemius internus.

PLATE XVIII.—LIGATURE OF THE POPLITEAL ARTERY.

Two different processes for this operation are shown in the plate.

Fig. 1. (A A²). Incision in the middle line of the hollow of the ham. (*Ordinary process.*)

- a. Index and middle finger of the surgeon's left hand, drawing outwards the external lip of the wound.
- b. Fore finger of an assistant, drawing the inner margin of the wound in the opposite direction.

1. Line of section of the skin.
2. Division of the aponeurosis of the thigh.
3. Prominence formed by the semi-membranous muscle.
4. Prominence formed by the biceps flexor cruris.
5. Internal division of the popliteal nerve.
6. External saphena vein.
7. Popliteal vein.

8. Popliteal artery, raised at (9) on the common aneurismal needle, and at (10) on the point of a bent director.

Fig. 2. (B B²). Incision upon the inner side of the limb. (*Process of Marshal.*)

- a. The two fingers of an assistant, pressing backwards the gastrocnemius muscle.

1. Edges of the divided integument.
2. Division of the aponeurosis of the leg.
3. Internal saphena vein.
4. Saphenus nerve.
5. Margin of the gastrocnemius internus or soleus.
6. Tendons of the gracilis and semi-tendinosus muscles.
7. Popliteal vein.
8. Popliteal nerve, carried backwards.
9. Popliteal artery, resting on the popliteus muscle.
10. Græfe's aneurismal needle passed under the artery.

Fig 1

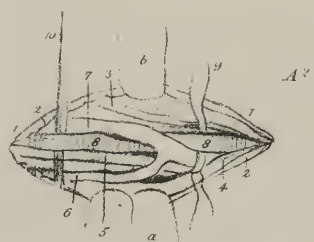
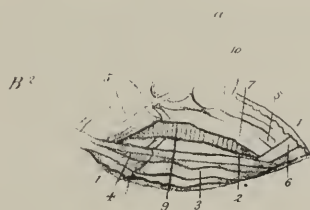
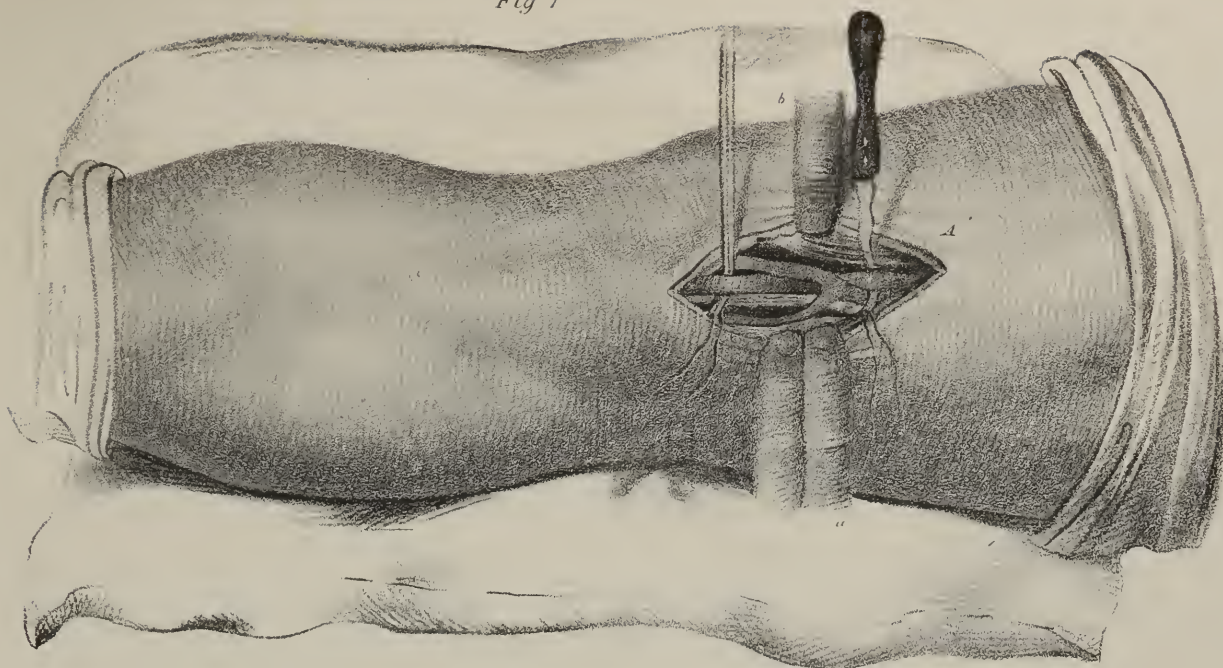
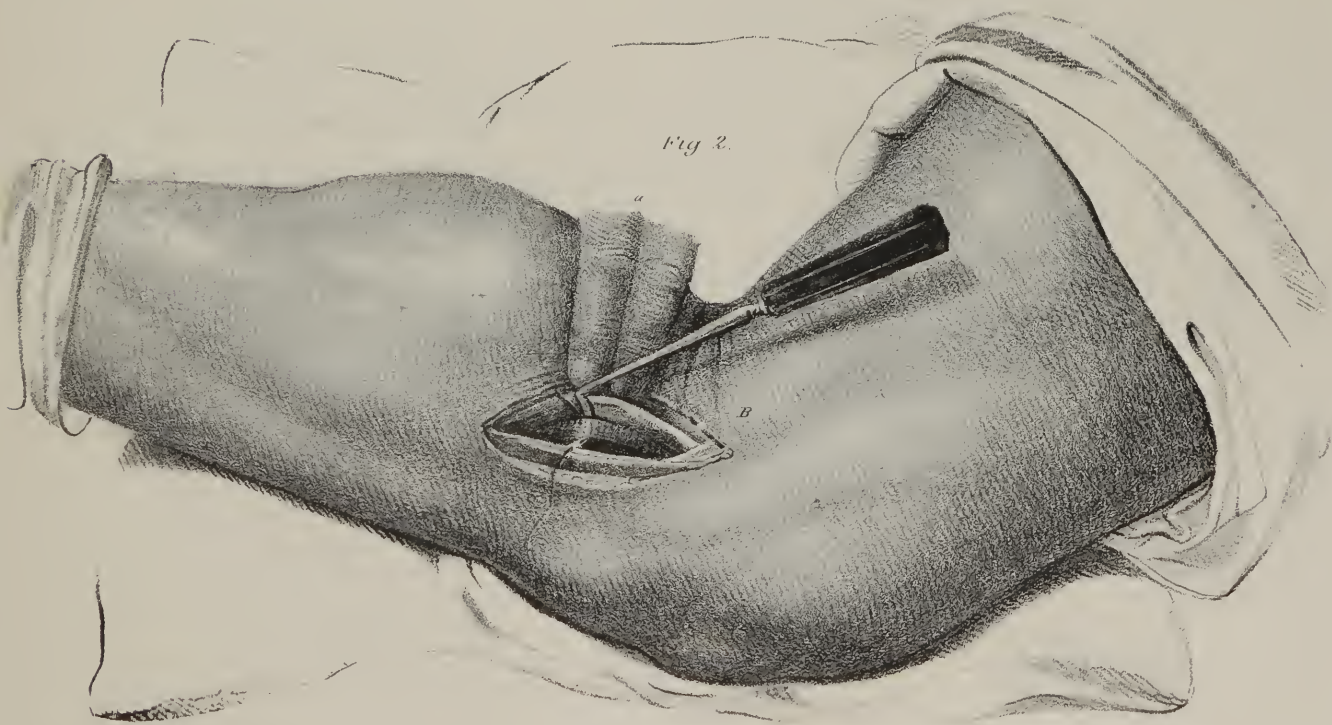


Fig 2.



It has not yet, however, been sanctioned by use on the living subject.

Operation.—The patient is to be placed on his back or side, and the limb abducted and laid on its outer border, with the thigh and leg slightly flexed and supported by a pillow. The surgeon feels for the groove which exists between the internal border of the inner head of the gastrocnemius and the internal spine of the tibia, and follows it obliquely backwards till he feels the prominence of the soleus. In the course of the groove thus depressed with the fingers, he makes an incision of three inches, commencing just below the point where the tendons of the sartorius, gracilis, and semi-tendinosus sweep round upon the tibia. The saphena vein and its attendant nerve, exposed by the division of the skin, are to be drawn forwards, and the superficial fascia and the deep-seated aponeurosis of the leg, which is here very thick, laid open. The internal head of the gastrocnemius is now to be separated with the finger or director, and drawn strongly outwards with the blunt hook. At the depth of about an inch we find the vessels. The vein first appears, covering the artery, which lies to its outer side,—the popliteal nerve being situated between and behind them. The vein is to be slightly denuded, and drawn backwards and outwards with a blunt hook or the fingers of an assistant. The artery then comes into view, resting on the surface of the popliteus muscle, and is to be raised with the aneurismal needle.

M. Jobert has proposed to tie the artery above the joint, by a somewhat analogous process—making a lateral incision on the inner side between the vastus internus and the inner hamstring tendons.

OF THE ARTERIES OF THE LEG.

LIGATURE OF THE ANTERIOR TIBIAL UPON THE LEG.

Surgical anatomy.—This artery, arising from the popliteal just below the muscle of the same name, passes directly forward in an opening in the interosseous ligament, between the head of the fibula and the outer margin of the tibia. From this point it is directed downwards in a straight line to the middle front portion of the ankle joint. In all this course it gives off but one branch of importance, the recurrens tibialis. For the three superior fourths of the leg it rests on the anterior face of the interosseous ligament, and upon the tibia in its lower fourth. It is accompanied by two veins, and crossed diagonally by the anterior tibial nerve, so that the latter is found external to it above, anterior in the middle, and internal below. In the upper third of the leg this artery is situated between the belly of the tibialis anticus muscle, (which lies upon its inner side and overlaps it,) and the extensor digitorum communis on its outer, and is placed on an average about an inch below the surface. In the middle third of the leg it still has the tibialis anticus at its inner side; and is bounded on its outer by the extensor pollicis pedis, which shortly crosses in front of the artery so as to get to the opposite side. At the inferior third of the leg the artery becomes much more superficial, and is lodged between the tendons of the extensor pollicis and the extensor communis digitorum pedis.

Anomalies.—The anterior tibial artery has been occasionally observed placed quite superficially below the integuments. The posterior interosseal sometimes comes in front of the interosseous ligament, and throws itself as a trunk of considerable size into the anterior tibial.

Remarks.—True aneurism of the anterior tibial artery is a rare affection, and the author does not remember to have observed more than two instances of it in the course of his practice; false aneurismal tumours, diffused or circumscribed, the consequence of wounds, are, on the contrary, not unfrequently met with. If the wound implicating the artery be recent, the surgeon may dilate it if not sufficiently open; or if a small aneurism have formed, cut down upon the vessel, and apply in either case a ligature above and below the place of its injury. The necessity of this double application of the ligature always increases the farther the injured vessel is removed from the centre of the body, for the greater then will be the degree of intercommunication which exists by anastomosis between the surrounding branches. But if the vessel be affected in the upper fourth of the leg, the depth at which it is placed and the disturbance of the muscles necessary to reach it there, will in general make it preferable to secure the femoral at the middle region of the thigh. The *place of election* in ligature of the anterior tibial, is the *middle* third of the leg. At the lower third, the artery is too closely in relation with the sheaths of the tendons and the ankle joint, and in the upper is too deeply placed to be cut down upon except in cases of necessity.

LIGATURE IN THE MIDDLE OR UPPER THIRD. (PL. XIX.)

Operation.—The patient rests on his back, with his leg extended, and held at the knee and foot by two assistants. The surgeon takes his position at the outer side of the limb. He traces out in his mind or marks with the handle of a scalpel the line of direction of the vessel, causes the patient to flex and extend the foot so as to render the position of the anterior tibial muscle more conspicuous, and feels with the fingers of the left hand for the groove along the external border of this muscle. The skin is to be opened by an incision three inches long, directly over the vessel lodged in this groove; or, which I greatly prefer, in a direction obliquely across the course of the vessel, commencing over the anterior tibial muscle, a half or three-quarters of an inch from the spine of the tibia—and crossing the vessel so as to terminate below as much at its outer side. On the right side the incision is to be made from above downwards; and on the left from below upwards. The superficial fascia and aponeurosis are next to be slit the whole length of the wound, and divided transversely for half an inch or more at either end of the incision, so as to facilitate the separation of the muscles. We then seek with the finger for the first cellular groove, or the first yellowish intermuscular line (starting from the end of the incision next the tibia), which will be found between the tibialis anticus on the outer side, and the extensor pollicis pedis, or the extensor communis digitorum, according as the operation is in the middle or upper part of the leg. This space is to be opened by rupturing the cellular tissue between the muscles the whole length of the wound with the index finger merely, or the point of a director. The foot is to be flexed, and the muscles in question thus relaxed are to be held asunder by the

fingers of an assistant, or with blunt hooks. The sheath of the vessels is now exposed at the bottom of the groove, and is to be raised with the forceps and opened. The nerve is to be drawn to one side, and the sheath of the vessels seized on the outer side of the artery with the forceps; the artery is then to be isolated from its accompanying veins, and raised on the director. In consequence of the depth of the vessel the director should be slightly curved; and if presented diagonally, it will pass more readily under the artery. If the rules here laid down for discovering the groove in which the vessels are lodged, are not regularly followed, the operator may get too far from the tibia, and fall into the space between the two extensors. Should this happen, it will be necessary for him to look about a third of an inch to the inner side of this opening for the intermuscular space by the outer side of the *tibialis anticus*.

In the operation for tying the artery at the upper third of the leg, Lisfranc proposes to make the external incision in an oblique direction from the head of the fibula to near the crest of the tibia; it has, however, no particular advantage over the process already described. In ligature of the artery at its lower third, the vessel will be found between the two extensors, and is so superficial that its position is readily detected by its pulsations.

LIGATURE OF THE ANTERIOR TIBIAL ON THE DORSUM OF THE FOOT.

Surgical anatomy.—From the middle of the interval between the two malleolar processes, the artery is continued forwards in a straight line to the interosseal space between the metatarsal bones of the first and second toe, where it dips down to the sole of the foot. It rests upon the tarsal bones, and runs between the *extensor pollicis pedis*, which is on its inner side, (and serves as a guide for the vessel,) and the first tendon of the short common extensor at its outer; the muscular fibres of the latter slightly cover the vessel, and constitute the first point to be looked for in the operation. The vessel is situated nearly a third of an inch below the skin, covered by the dorsal aponeurosis, and a second fibrous expansion spread between the extensor tendons, and is accompanied by two veins and a nerve. Its pulsation, nevertheless, can usually be readily felt.

Remarks.—This artery, as has already been observed, is occasionally increased in size by union with the posterior interosseal. On the other hand, it is sometimes entirely deficient, or so small that it is with difficulty distinguished in operations on the cadaver. It may be tied in any part of its course, but the middle of the tarsal arch is the place usually preferred. Its proximity to

PLATE XIX.—LIGATURE OF THE ANTERIOR TIBIAL ARTERY.

Fig. 1. The limb is laid on a pillow, with its external and anterior surface looking upwards.

(A A²). AT THE UPPER THIRD.

1. Line of division of the skin.
2. Aponeurosis of the leg laid open.
3. *Tibialis anticus* muscle, carried inwards by a blunt hook.
4. *Extensor communis digitorum pedis*, pressed outwards by two fingers of the surgeon's left hand.
5. Sheath of the anterior tibial vessels.
6. Anterior tibial nerve.
7. *Venæ comites* or satellite veins.
8. Anterior tibial artery raised on the aneurismal needle.

(B B²). AT THE JUNCTION OF THE MIDDLE WITH THE INFERIOR THIRD OF THE LEG.

1. Line of division of skin.
2. Aponeurosis of leg.
3. Anterior tibial tendon, carried inwards.
- 4, 5. Extensor tendons of the toes, carried outwards.
6. Anterior tibial nerve.
7. *Venæ comites*.
8. Anterior tibial artery raised on the director.

(C C²). ON THE DORSUM OF THE FOOT.

1. Incision of the skin.
2. Incision of the dorsal aponeurosis of the foot.
3. Inner margin of the *extensor brevis digitorum* carried outwards.
4. Tendon of the *extensor proprius* of the great toe.
5. Anterior tibial artery between its two veins, raised on the ligature.

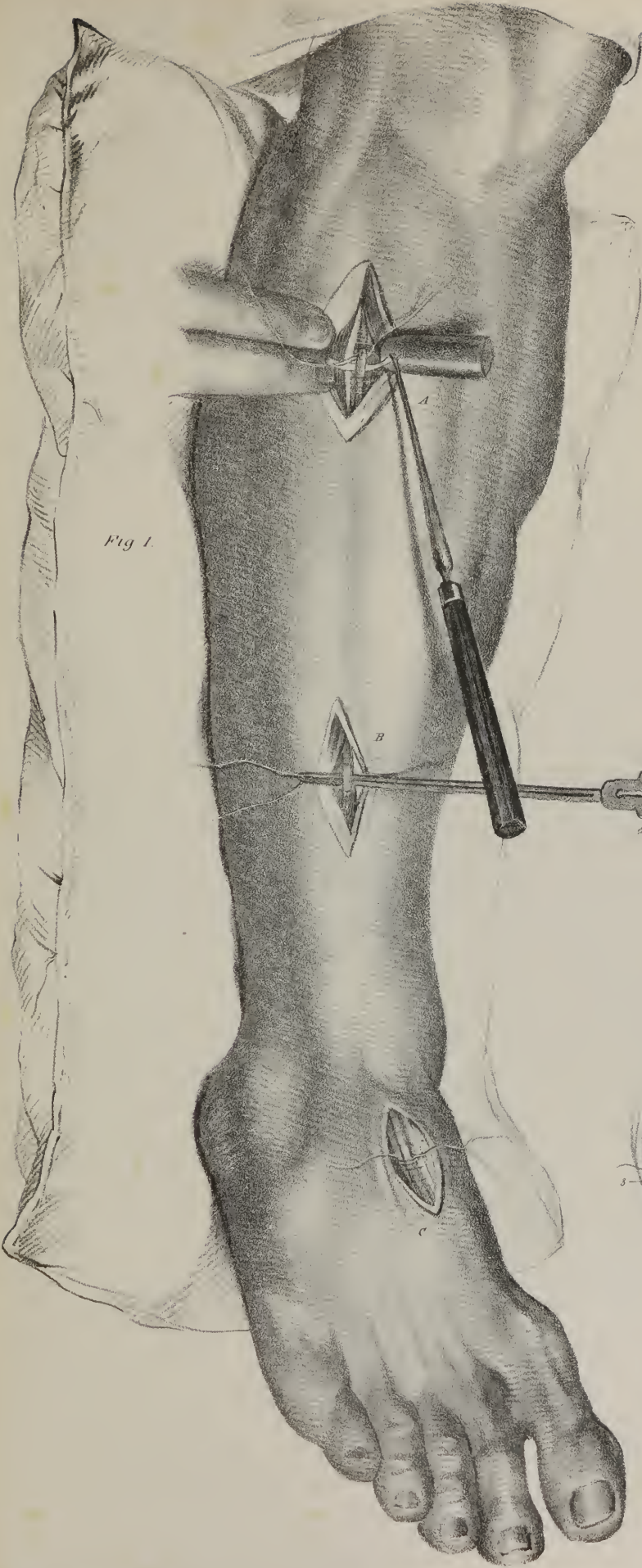


Fig. 1.

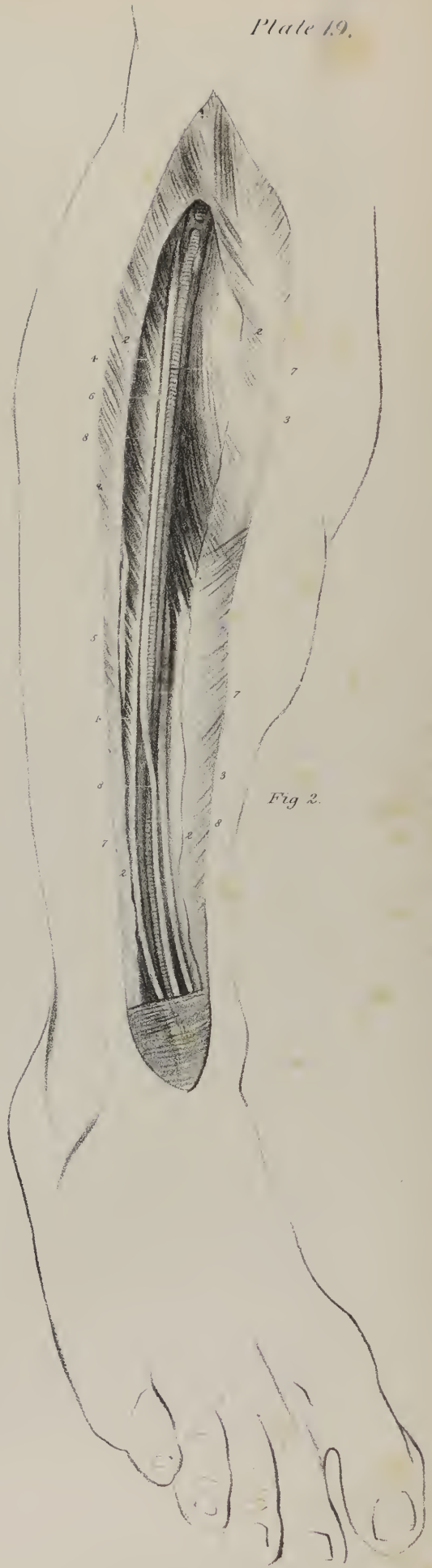
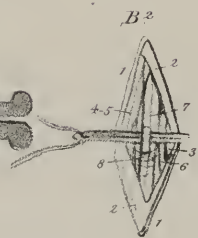


Fig. 2.

the tarsal bones enables us, in cases of wound, to apply compression with so much advantage that ligature of the vessel at this point may frequently be dispensed with.

Operation.—The foot held in extension, an incision two inches long is to be made directly over the course of the vessel, the lower end of the incision being opposite the posterior angle of the first interosseous space. The subcutaneous cellular tissue, and the dorsal aponeurosis, having been divided on the director, we fall upon the first tendon of the extensor brevis digitorum communis. The inter-tendinous fascia is next to be opened along the inner border of this muscle, and the muscle itself drawn a little outwards. The sheath of the vessels appears immediately below, which is to be opened, and the artery isolated and tied in the usual manner—the director being passed below it from within outwards.

LIGATURE OF THE POSTERIOR TIBIAL.

Surgical anatomy.—The posterior tibial artery, from its size and direction, may be considered the continuation of the popliteal, from which it comes off about two inches below the articular surface of the tibia. It is placed on the posterior part of the leg, and passes down nearly in a straight line, from the central hollow of the ham to the middle of the space between the internal malleolus and the tendo achillis, curved slightly inwards near the middle. Above, it rests by its anterior face on the tibialis posterior muscle; in the middle part of its course, upon the flexor longus digitorum; and near the ankle, it is separated only by a padding of fat and cellular tissue from the bone. Throughout its course it is covered on its posterior face by the deep-seated aponeurosis of the leg; which separates the superficial from the deep layer of muscles; and for the upper two-thirds of the leg, by the gastrocnemius and soleus. Below, these muscles become tendinous, and depart from the artery so as to leave it superficial where it runs down at the inner side of the tendo achillis, being covered there only by the skin and two aponeurotic layers. It then turns round the os calcis, midway between the tendon and malleolus, from the latter of which it is separated only by the tendons of the posterior tibial, and flexor communis muscles, both of which are lodged in a groove in the bone and protected by a sheath. It is accompanied throughout its course by its two veins, and the posterior tibial nerve which lays to its outer side. At the top of the leg, as before observed, the artery is nearly in the middle line, and an inch to an inch and a half below the surface. In the middle third, it is about an inch from the outer edge of the tibia, and at a hand's breadth above the ankle, only half an inch.

Remarks.—This artery is little subject to anomaly; it has, however, been found in a few instances very small or entirely wanting. It may be tied at the superior, middle, or inferior part of the leg; or, in case of necessity, in any other portion of its course. The operation is usually called for in consequence of a direct injury from a wound; and in such cases, for reasons already mentioned, it is advised to apply two ligatures—one above and one below the place of lesion. True aneurismal tumours occur but rarely in the course of this vessel. Diffused false aneurisms may attain here to a size considerably greater than those observed on the anterior tibial, in consequence of the greater extensibility

of the surrounding tissues. The vessel is placed so deeply in the upper third of the leg, that it cannot be reached but by a deep and extensive wound, and very considerable derangement and some destruction of the muscular fibres. In most instances where it would not answer to secure the artery lower down, we should best promote the safety and comfort of the patient, by tying in preference the femoral in the middle region of the thigh. But in a wound complicated with extensive effusion of blood between the muscles, we have the high authority of Mr. Guthrie for securing the popliteal trunk. This surgeon, in the instance alluded to, preferred to the ordinary operation, the splitting down of the muscle in the middle line of the calf.

LIGATURE IN THE UPPER THIRD. (PL. XX.)

Operation.—The leg should be half flexed so as to relax the muscles, and laid flat upon its inner side. Three quarters of an inch to an inch (according to the muscularity of the limb) behind the inner edge of the tibia we make an incision, four inches in extent—parallel with that bone; or slightly approaching the bone below, which I prefer, as being more directly over the course of the vessel. The superficial fascia and aponeurosis are to be divided to the same extent, taking care to avoid the saphena vein, which runs up nearly in the direction of the cut. A crucial incision should be made across the aponeurosis at the two extremities of the wound. The internal head of the gastrocnemius is now exposed, the cellular connections of which, on its anterior surface, are to be separated with the finger or director, and the muscle itself drawn outwards on a blunt hook. The belly of the soleus, which arises in great part from the tibia, now comes into view;* this is to be divided layer by layer with the knife after the manner of Manec, in the direction of the external wound, and at the distance of about three quarters of an inch from the tibia. After dividing the belly of this muscle, we fall upon its tendinous fibres of insertion, which form a strong, white, shining layer. This is to be raised on the director, and divided the whole length of the wound. We come next to the deep-seated muscular aponeurosis, which is to be cautiously opened and divided in the same manner on the director. The vessels enveloped in their sheath are now fully exposed. The sheath is to be opened, the artery denuded in the usual manner, and the aneurismal needle passed below it from within outwards.

LIGATURE AT THE MIDDLE THIRD OF THE LEG. (PL. XX.)

Operation.—Take for a starting point in this operation, the posterior or internal angle of the tibia, which may always be readily discovered by depressing the mass of muscles on its posterior face. By the older method it was customary to open the skin, by an incision parallel with the tibia, and about half an inch from its

* By the old method it was customary to shave the soleus off directly at its connection with the tibia, and then draw the muscle outwards, in place of dividing the belly of the muscle as directed in the text. This process serves easily enough to expose the vessels on the dead body; but is attended with much difficulty on the living subject in consequence of the strain of the muscle, and the excessive contraction to which it is provoked. To overcome this resistance, M. Bouchet, of Lyons, was compelled to divide the soleus directly across over the course of the vessel.

internal border. But there is greater certainty of falling directly upon the vessels, by adopting the following modification of Lisfranc. Make an incision of two and a half to three inches in extent obliquely downwards and backwards from the posterior angle of the tibia to the inner border of the tendo achillis, so that it shall form with the axis of the leg an angle of about 35 degrees, and cross diagonally over the intermuscular groove in which are lodged the vessels. Divide in the same direction the superficial fascia and aponeurosis; glide the fore finger, with its palmar face turned backwards, into the bottom of the wound and under the tendo achillis, and sweep it upwards and downwards so as to detach the cellular connections freely; the belly of the soleus comes into view as it leaves the tibia, forming the upper border of the wound,

and is to be drawn upwards and backwards, or if it descends low upon the artery, divided together with its aponeurosis of insertion at its origin from the tibia. At the bottom of the wound is next observed the shining deep-seated intermuscular aponeurosis, covering the vessels. This is to be punctured so as to admit the grooved director below it, and freely divided. The sheath of the vessels which is now exposed is to be opened, and the artery isolated and tied in the usual manner. The same process as here described is applicable to the ligature of the artery in any part of its inferior third.*

* It is perhaps useless to repeat that the incision must be made from above downwards, or below upwards, according as we act on the right or left limb. The description in the text is confined to the right side.

PLATE XX.—LIGATURE OF THE POSTERIOR TIBIAL AND PERONEAL ARTERIES.

Fig. 1.—Of the posterior tibial. The leg rests upon a pillow, and is laid upon its outer side.

(C C²). AT ITS UPPER THIRD.

1. Division of the skin and superficial fascia.
2. Division of the superficial aponeurosis of the leg.
3. Section of the soleus muscle, made near its attachment upon the tibia. One portion is carried towards the tibia by the left fore finger of the operator; the other is carried backwards by the fingers of an assistant, so as to make the wound gape.
4. Section of the *aponeurotic tendon of the soleus*.
5. *Deep-seated aponeurosis of the leg* covering the flexor muscles of the toes, and separating them from the soleus.
6. Posterior tibial artery, exposed between its satellite veins and raised on the aneurismal needle.

(B B²). AT THE INFERIOR THIRD OF THE LEG.

- 1, 2. Division of the skin and superficial aponeurosis.
3. Division of the deep-seated aponeurosis covering the flexor muscles of the toes.
4. Posterior tibial artery isolated and raised from between its veins on the grooved director.

(A A²). BEHIND THE INTERNAL MALLEOLUS.

The lips of the wounds are held separate—posteriorly by a blunt hook—anteriorly by the fore finger of an assistant.

- 1, 2. Division of the skin and superficial aponeurosis of the leg.
3. Division of the deep-seated aponeurosis, which covers the flexor tendons as well as the artery.
4. Posterior tibial artery, raised on the ligature.

Fig. 2.—Anatomical relations of the vessel, designed to illustrate the three preceding operations.

- 1, 2, 3, 4, 5, designate the same parts as in the three side sketches.
6. Internal part of the gastrocnemius externus.
7. Posterior tibial nerve.
8. Posterior tibial artery, between its two veins.
9. Superficial or investing aponeurosis of the leg.
10. Internal saphena vein.
11. Saphenus nerve accompanying the vein.
12. Tendo achillis.
13. Tendon of the flexor longus communis digitorum pedis. Both these tendons are seen through the deep-seated aponeurosis.

Fig. 3.—Of the peroneal or fibular artery.

- 1, 2. Division of the skin and superficial aponeurosis.
3. Peronei muscles carried in front by a blunt hook.
4. Division of the peroneal attachment of the flexor pollicis muscle.
5. Peroneal artery between its satellite veins. The artery is raised on the aneurismal needle.

Fig. 1.

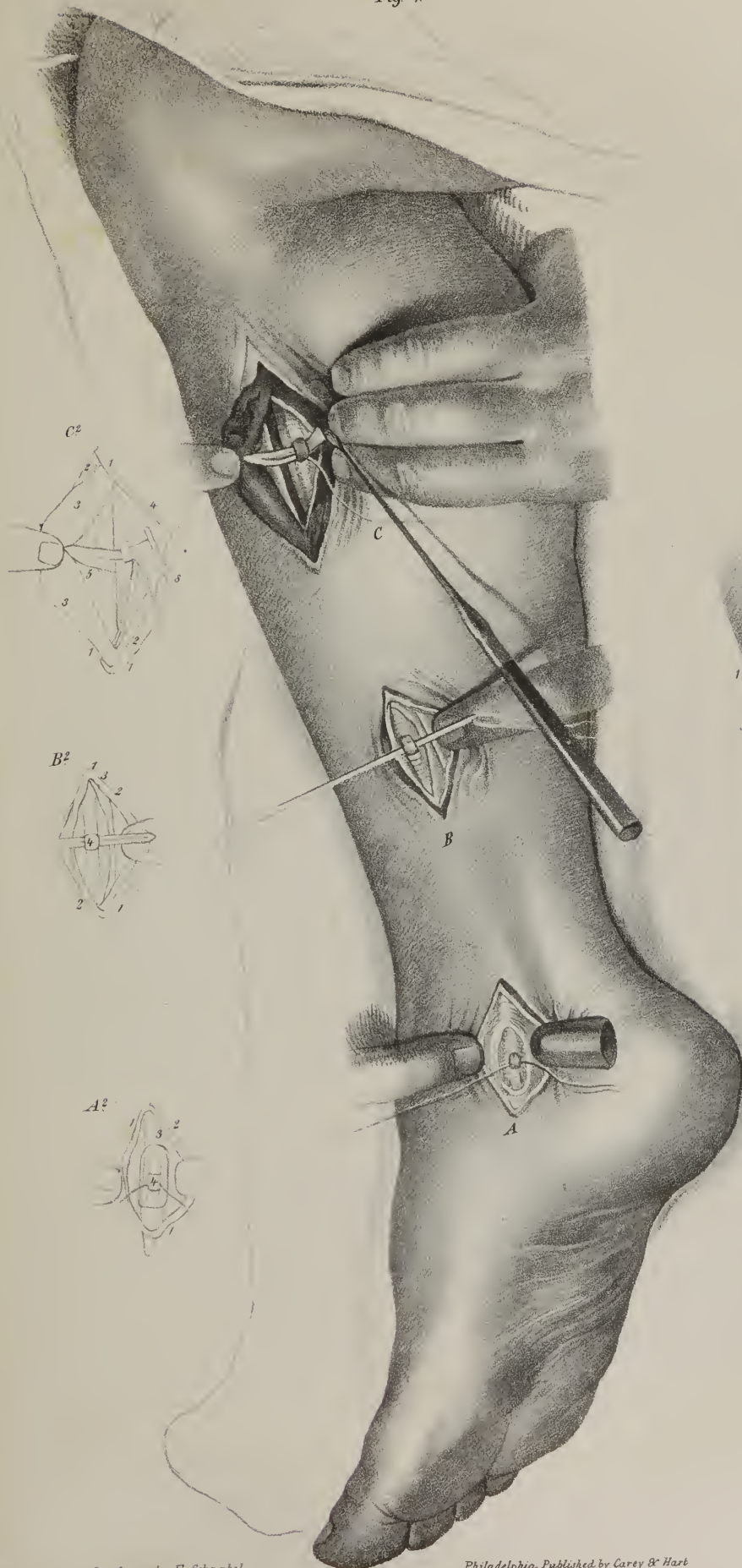


Fig. 3.

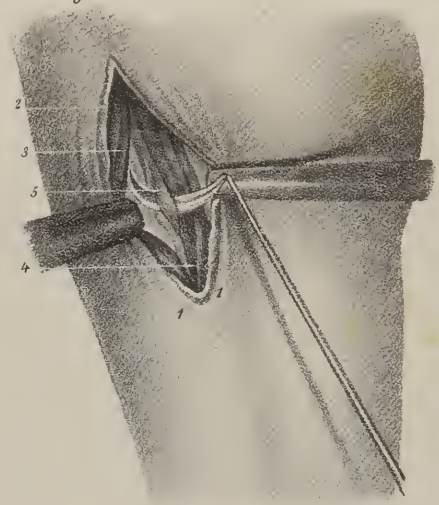
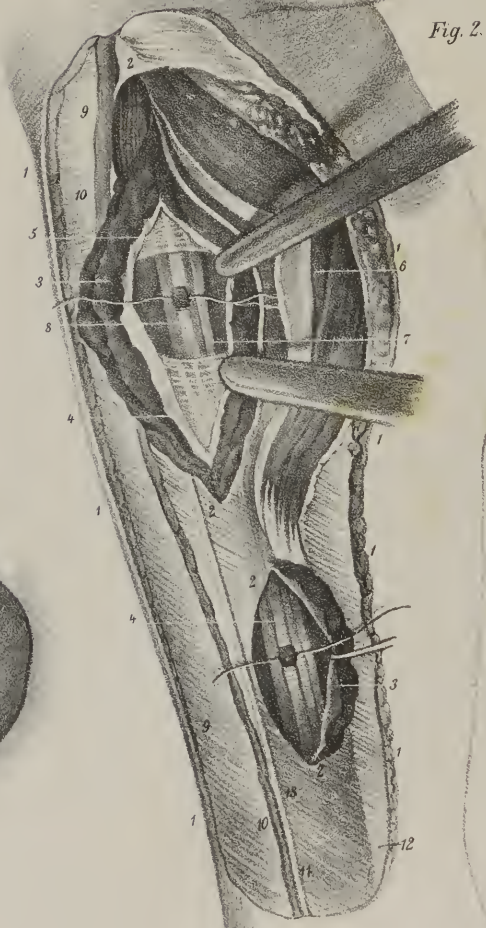


Fig. 2.



LIGATURE BEHIND THE MALLEOLUS INTERNUS. (PL. XX.)

Surgical anatomy.—The artery is curved, as before observed in its course behind the malleolus, presenting a concavity in front. At the end of this curve it is divided into its two plantar branches. It is lodged in some dense cellular tissue, accompanied by its veins, and with the nerve at a little distance behind it. It is covered by the superficial and deep-seated aponeurotic membranes, which are often strengthened by some fibres from the annular ligament of the joint. It is found about a finger's breadth behind the malleolus, and in the middle of the space between it and the tendo achillis. The tendons of the two muscles which separate it from the malleolus are each covered by respective portions of ligament, and ought not to be seen at all in the operation upon the artery.

Remarks.—Wounds of the foot involving the plantar branches are the most frequent causes which render necessary the ligature of this portion of the artery; for it would be most unwise, as well as extremely painful and difficult, to cut down upon the plantar branches, which are lodged in the sole at a depth of at least three quarters of an inch. The remarks made in reference to ligature and compression of the arteries of the hand, are equally applicable to those of the foot. It is quite practicable to arrest the circulation of blood in this vessel by compression behind the ankle, but this method becomes after a short time too painful to be borne. The case, however, can hardly be conceived, except there be direct wound of the vessel in this region, in which ligature of the trunk in the inferior third of the leg would not be equally efficacious as that behind the ankle; and as the latter process is liable to be followed by chronic inflammation of the ligaments of the joint or the sheaths of the tendons, the former operation ought, in the opinion of the author, to be preferred.

Operation.—The limb is to be placed in the position indicated for the two operations last described, and a vertical incision of two inches in length made in the middle line between the tendo achillis and the internal malleolus. The fibrous subcutaneous cellular tissue is to be cut with the skin. The superficial aponeurosis is to be raised carefully and cut on the director. A layer of fatty tissue covering immediately the deep-seated aponeurosis next comes into view, both of which are likewise to be divided on the director. The sheath of the vessels which is now exposed, is to be opened, and the artery isolated on either side and raised on the director according to the usual process.

LIGATURE OF THE PERONEAL ARTERY. (PL. XX.)

Surgical anatomy.—The peroneal artery comes off from the posterior tibial below the popliteus muscle, and runs down along the internal face of the fibula, from which it is separated only by the flexor longus pollicis pedis. Near the os calcis, it terminates by dividing into two branches. In the upper part of the leg, it is covered by the soleus muscle; in the lower half, it is more superficial. It rests on the interosseous ligament, and in the intermuscular fissure between the flexor pollicis and the tibialis posticus muscles. Very frequently, however, it is found lodged in the midst of the fibres of the first named muscle. It is covered

by the superficial and deep aponeurotic membranes, like the artery last described.

Remarks.—This artery rarely requires to be tied, except in cases of compound fracture or punctured wounds. Too deeply seated above to become the subject of operation, and so small below as to render it unnecessary, it is only in the middle third of the leg that it can be requisite to tie it. In traumatic injuries of the upper third, necessitating some remedial measure, it would be better surgery to secure the femoral artery than to do so much violence to the deep-seated structures of the leg as would be necessary to reach the peroneal in that region. The peroneal artery, it is to be recollected, lies between the tendo achillis and the fibula, while the posterior tibial lies on the opposite side of the limb, between the tendo achillis and the tibia.

Operation.—The leg is to be semiflexed and placed upon its inner face with the front portion turned toward the operator. The foot should be extended and its external margin elevated so as to relax the gastrocnemial and peronei muscles. An incision below the middle of the leg of two to two and a half inches in extent, is to be made after the method of Lisfranc, between the external border of the tendo achillis and the external face of the fibula, taking care to avoid injury of the external saphena vein, by first cutting merely the skin, and drawing the vein to one side before the deeper parts are divided. The incision should be directed at an angle of about thirty-five degrees with the course of the vessel. The superficial fascia and aponeurosis are next to be cut. With the index finger, we then push inwards the tendo achillis, and destroy the cellular tissue down to the deep-seated aponeurosis, which is stretched between the tibia and fibula. An assistant now draws the tendo achillis inwards. The deep-seated aponeurosis is next to be raised and divided on the grooved director. Starting from the fibula, we look for the first intermuscular space below this aponeurosis, which, if it interfere with the separation of parts, may, as well as the superficial, be cross cut at the two extremities of the wound. This space is to be opened with the finger, and we fall upon the vessel lodged between the two muscles already noticed,—the flexor pollicis and the tibialis posticus. The flexor pollicis is to be drawn outwards, and the sheath of the peroneal vessels comes into view deep behind the fibula. The sheath is to be opened, and the artery isolated and raised upon the aneurismal needle or with a director highly curved and passed diagonally below it. In case the artery be lodged among the fibres of the flexor muscle, these must be cautiously cut till we reach the vessel; or should there be difficulty of succeeding by other means, the muscle with the artery may be cut across, and the bleeding orifice of the latter secured with the tenaculum and ligature—pressure being made at the time on the femoral so as to prevent much effusion of blood.

By the older method, a straight incision was made directly over the course of the vessel; but it does not afford the same degree of certainty of falling directly upon the artery, especially if we tie it at the usual point, below the middle of the leg, and just at the place where the soleus and external gastrocnemius tendons join.

III. OPERATIONS FOR DISEASES OF THE BONES AND JOINTS.

Under this head will be considered:—1. The operations for dropsy of the joints. 2. Those for the removal of foreign bodies from the joints. 3. For ganglions or cysts on the bursal sheaths of the tendons. 4. For hygroma or dropsical tumours of the *bursæ mucosæ*. 5. For complicated fractures and luxations. 6. For false joints, or ununited fractures. 7. For deformities from the irregular union of broken bones. 8. For exostosis. 9. For cysts in the bones. 10. For necrosis. 11. For trephining—and, 12. For resection of the bones.

HYDRARTHROSIS.—ARTICULAR DROPSY.

Every articulation consists of the extremities of two or more bones appropriately fitted to each other, covered with a smooth, polished, elastic substance called cartilage, and held firmly together by strong inelastic bands called ligaments; and as in all machinery where there is much motion, it is necessary to interpose some unctuous substance to prevent friction, there is in every movable joint a slippery fluid called synovia, thrown out by the inner membrane which lines it. This is undergoing a continued process of secretion and absorption, exactly proportioned to the degree of motion to which the joint is subjected.

As a sort of secondary ligaments, serving to strengthen the articulation, we have the tendons of the muscles playing over them, and sometimes, as in the shoulder, apparently passing through the joint itself. Each of these in the neighbourhood of the joints is provided, for the same purpose as the joints themselves, with the same secreting membrane, which is extended along the tendon in the form of a long purse or bursal sheath, and when distended is about three or four times the diameter of the tendon it embraces. Not only in the joints and around the tendons, but wherever there exists steady friction in the play of parts, as that of the skin or a tendon over a bone or other resisting structure, do we find the same kind of serous sac under the name of *bursa mucosa*.

All these closed secreting sacs, like other serous membranes, are liable to an accumulation of their fluid contents, constituting dropsy. This is, however, most generally but a symptom occasioned by a sprain, wound, contusion, some internal affection of the joint, or the development of movable cartilages,—and may usually be removed by antiphlogistic treatment, conjoined with rest and compression. The *joints* most subject to this dropsical accumulation are the large ones, the knee, elbow, hip, and wrist. The bursal sheaths most commonly affected, forming the tumours called ganglions, are the ones subjected to most frequent movement; viz., those which cover the wrist. The *bursæ mucosæ* most commonly found distended, are those most liable to compression—as the one between the skin and ligamentum patellæ, forming when enlarged by disease the affection known as the housemaid's knee, and the one covering the olecranon, which, from being commonly observed among miners who rest much on the elbow, constitutes in its morbid condition what has been called the miner's elbow.

Dropsy of the knee joint.—When the synovial fluid has increased to such a quantity as to properly constitute this disease,

we find a soft fluctuating tumour with no change of colour in the skin, which yields to the pressure of the finger, without leaving an impression as in œdema. If the leg be stretched, the patella can be made to strike on the condyles and rebound. If there be a communication, as is most commonly the case, between the joint and the bursa above the condyles of the os femoris, there will also be a great degree of fullness or swelling under the extensor tendons. The capsule protrudes at both sides of the patella and rectus tendon, but most on the internal, and is very tense when the knee is bent. A protrusion of the capsule sometimes takes place into the popliteal region when the leg is extended, to which the artery of the ham from its proximity communicates a pulsatile movement. By bending the joint, however, the tumour disappears, and its nature is at once made known.

In *dropsy of the elbow joint*, the distension of the capsule forms an oblong tumour on either side of the olecranon process, when the forearm is extended.

At the *ankle joint*, the fluctuating tumour is obvious chiefly in front of the malleolar processes.

At the *wrist*, it is scarcely perceptible on the sides of the joint; it is observed to some extent on the back part, but is found mainly on the front portion of the articulation.

At the *shoulder* it is found on the front portion of the joint, and is especially obvious between the deltoid and pectoral muscles.

Operation.—All therapeutic measures having failed, after a thorough trial to cause a removal of the dropsical accumulation, we may discharge it either by incision with a bistoury, or puncture with a trocar. The great object in the operation is to avoid the entry of air, which might provoke irritation in the cavity of the joint, and give rise either to suppurative inflammation of the serous membrane, or even ulceration of the articular surfaces. The operation is, therefore, not unattended with danger, and is only to be undertaken when the patient is not able, by the aid of a compressing bandage, to serve himself with the limb. The bistoury is to be preferred to the trocar, as the incision it makes is not more irritating than the puncture with the latter instrument, and allows better the discharge of the flaky pus sometimes found mixed with the serum, or of a movable cartilage, the presence of which is occasionally discerned only after the fluid has in part escaped.

We should select the most depending portion of the tumour, and if possible at the same time the most prominent. If it be the knee, and seldom any other joint requires the operation, the inner portion is selected, as the limb can be so turned as to make it dependent. The skin being drawn to one side, in order to prevent any parallelism between the inner and outer portions of the wound, the bistoury is to be passed in perpendicularly to the surface, and the incision moderately enlarged as it is withdrawn. After the discharge of the fluid, a simple dressing is to be laid over the wound, and the limb, which is to be kept for a couple of weeks or more perfectly at rest, covered with a compress wetted with Goulard's or some other resolvent lotion. The fluid is so soon reproduced, that Boyer directs at the end of twenty-four hours to re-open the incision and discharge it anew. If the lips are merely slightly agglutinated he would separate them with a director, or with a bistoury if the union be more firm. If there is a probability of having to make several successive punctures, his direction is to keep

the passage open, by introducing through it a strip of linen or some charpie. But I have preferred in my own practice, to this constant presence of a foreign body in the cavity of the joint, an occasional oblique puncture under a valvular fold of the skin; resorting to gentle compression after each operation, in order to overcome the tendency to a re-accumulation of the fluid. Floculent portions of pus or decayed membranes may be occasionally washed out with advantage by emollient injections; and as a subsequent treatment, an injection of the same sort allowed to remain in the cavity of the joint as directed by Récamier, it is said has been attended with advantage.

M. Malgaigne prefers the use of the trocar, and, contrary to common experience, asserts that the puncture of the articulations is an operation perfectly innocent. He has operated, he observes, six times in this manner for dropsy of the knee joint without the least inconvenience. He only regards it as insufficient of itself for a cure, requiring in addition the use of compression, counter-irritation, and the various other therapeutic means to effect radical relief. However, there is always reason to fear that the paracentesis of a joint will be followed either by ankylosis, by suppuration from its cavity, by destruction of the cartilages, or caries of the bones. Weak iodine injections, after a partial removal of the fluid by tapping with an oblique puncture, have been employed with considerable success in this affection, by M. Bonnet of Lyons and M. Velpeau.

FOREIGN BODIES OR MOVABLE CARTILAGES IN THE JOINTS.

Cartilaginous bodies have been observed in several of the large ginglymoidal articulations, but their most common seat by far is in the knee joint. In the latter they commonly exist singly; seldom more than two or three are ever met with, though Morgagni mentions a case in which he found thirty-five; but when observed in the other joints, they are frequently found to exist in considerable numbers. Haller found twenty in the articulation of the jaw, and M. Malgaigne sixty in the elbow. They are variable as to form and size, and are usually smooth and polished. They seldom have the hardness of bone except at their centre, and are formed principally of soft and yielding cartilage, which is readily crushed under strong compression. They are distinguished according as they are loose or adherent, the consequence of some sprain or injury of the joint, and formed originally, as recent observations would seem to show, in the thin stratum of cellular tissue on the outer side of the synovial membrane; they project inwards towards the articular cavity as they increase in size, and finally are left hanging by a small pediculated portion of the investing synovial tissue. The pedicle very frequently gets broken off in consequence of the cartilage becoming pinched between the surfaces of the joint. In this state the cartilages remain afterwards as a loose foreign body and give rise every now and then to symptoms which make their diagnosis easy. Their presence is usually attended by an increased amount of synovial fluid which distends the capsule of the joint. When they rest between the capsule and the sides of the bones, little or no inconvenience is felt. But when they slip between the articular faces of the bones, as they are apt to do in a false step or a quick movement of the limb, violent pain is immediately produced. The cartilage soon sliding

back again into its former position, the movements of the joint in the course of an hour or two become perfectly restored.

Two measures of relief are resorted to in these cases,—compression and extraction.

Compression.—This consists in moving the foreign body which may be felt from without, to some corner of the articulation, where it will give rise to no inconvenience, and at the same time admit of its being compressed against a resisting base. In the knee, for instance, it may be carried above the patella, or on the side of one of the condyles of the os femoris. In this position, it is to be secured by adhesive strips, and firmly compressed by a well padded knee strap or a laced bandage. By a long continuance of these measures, the foreign body has in a few instances become fixed in its new position, so as to be no longer a source of discomfort. The difficulty of retaining it in its new location, and when we succeed in this, the frequent failure of the attempt to render it adherent, has caused the process to be in a great measure abandoned.

Extraction.—It is only in the knee as yet that the attempt has been made for the removal of these bodies. Before undertaking the operation, it is necessary by rest, and other appropriate means of treatment, to remove all pre-existing inflammation of the joint.

The patient being laid on the side of the bed, with his knee supported on a pillow, the operator searches for the foreign body. This will sometimes fly from before his fingers into the cavity below the patella or into the space between the condyles, and to displace it, it is necessary to cause the patient to flex or extend his limb. Having secured it, it is to be drawn on the outer or inner side of the joint, as is most convenient, and as high up as possible on the condyle of the femur. It is to be firmly fixed with the thumb and finger, or an acupuncture needle, the assistant at the same time drawing the skin upwards and outwards, so as to prevent any parallelism after the operation, in the wounds of the skin and capsule. An incision is then to be made in the direction of the limb, of a length in proportion to that of the body to be removed, at once down upon it, through both skin and capsule. The incision need seldom be more than from three-quarters to an inch and a half long. The continued pressure of the thumb and finger, which is not for a moment to be relaxed, brings the body upon the surface, and, if it is entirely loose, causes it to shoot out from the opening. If it hang by a pedicle, the latter is to be drawn out as far as possible, and snipped away with the scissors. If there exist several foreign bodies, they are all, if it can readily be done, to be drawn forwards and removed at the same orifice. If all cannot, however, be got away, without resorting to such manœuvres as would surely be followed by inflammatory action, it is better to close the wound, and extract them if it become necessary, at a subsequent operation. The orifice in the skin is to be carefully closed with adhesive plaster, and the knee surrounded with a bandage, which is to be kept wetted with a cooling lotion for the purpose of preventing inflammation. The limb must be kept for two or three weeks after in a state of perfect quietude, and should be sustained with a splint. It is usually recommended to place it in the state of extension, so that in case ankylosis should follow, it would be found in the most useful position. Malgaigne, however, recommends, and with some reason, moderate flexion as being less painful, and exposing less to the consecutive stiffness of the joint. In the course of twelve or fifteen

days after the operation, the author has been in the habit, and he thinks with advantage, of commencing gentle and passive motion of the joint, in order to prevent that union of opposite portions of the synovial membrane, constituting one of the varieties of false ankylosis which is here most apt to occur. This is a measure, however, deserving much care on the part of the surgeon; for it must be remembered, that the fearful consequences sometimes following these wounds of the joint do not usually show themselves before the eighth day.

To obviate the danger of this incision directly through the skin into the joint, it has been proposed by Goyrand to employ a subcutaneous operation. The foreign body being held fixed as above directed, a long shanked tendon knife is to be passed by a puncture through the skin, two or two and a half inches below the point at which the capsule is to be incised, and carried above the foreign body so as to divide on its withdrawal the capsule and the synovial membrane immediately covering it. The cartilage is to be squeezed out of the joint through this opening, and lodged in the subcutaneous cellular tissue, where it may be allowed to remain, or, if preferred, extracted at a subsequent period, after time has been given for the subcutaneous cut in the membrane of the joint to close. Before the knife is made to act on the capsule it should be pressed downwards, so as to loosen the integuments, and form a bed into which the foreign body may be readily pushed. This very ingenious method has been successful in several instances in which it has been employed, and appears to the author worthy of imitation, as being less likely to produce the terrible consequences that have sometimes followed the usual method, viz., suppuration and caries of the joint, extensive abscesses of the thigh, and even death.

ON THE BURSAL SHEATHS OF THE TENDONS.

Ganglions or synovial cysts,—hydatiform cysts.

The tendons of the muscles, as they play over the joints, especially those of the hand and foot, are placed, as has been before observed, in fibrous canals, the inner face of which is lined by a synovial membrane, reflected, as in the manner of other double serous sacs, over the surface of the tendon. Over the wrist and ankle, the fibrous canals for the tendons are partly formed by the annular ligament of the articulation, which passes on the outer surface of the tendons. From this cause, when the synovial sheaths are largely distended with fluid, the tumours which they form often bulge up irregularly above and below the annular ligament; the fluid when compressed, passing readily up and down underneath the ligament. On the palmar surface of the hand especially, the synovial sheaths are long, extending from a little distance above the wrist, with more or less interruption from transverse septæ, to the phalanges along the flexor tendons of the fingers. On the sole of the foot, the tendons which are deeply placed are likewise surrounded by bursal sheaths, and there is much reason to believe that many obscure and intractable cases of lameness arising from contusions in this region, may be attributed to disease of their bursal lining.

Ganglions, or synovial cysts.—The consequence commonly of a sprain or contusion, but arising often, like dropsy of the joints, without obvious external cause, they form indolent fluctuating tu-

mours without change of colour in the skin, along the tract of the tendons. They diminish or disappear when the tendon is relaxed, but increase when it is put in a state of tension by the muscle, so as to interfere more or less with the movements of the joint. When they have existed for a considerable period, no topical application whatever, or compression in any way that it can be applied, is to be relied on for their cure. The indication in these cases is to destroy the integrity of the shut sac, so as to allow the fluid it contains to be poured out in the surrounding cellular tissue, from whence it will be removed by the absorbents. This may be effected sometimes by sudden and strong compression with a letter seal wrapped in linen; or, which is more likely to succeed, by a sudden blow with the closed hand, or the back of a book, the extremity (the wrist being the point in which it is most generally observed), being placed on a firm support, as the surface of a table or the back of a sofa. The joint should be subsequently kept at rest for a few days, and bathed with an evaporating lotion, in order to obviate any tendency to inflammation, which in some cases might otherwise follow. Sometimes the sac will be found so strong as to resist all such efforts. It is then to be punctured with a tendon knife, or a small bistoury, which is to be introduced according to the subcutaneous method, the skin being previously drawn to one side so as to destroy the parallelism between the wound in the skin and sac, and thus prevent the introduction of air. Sometimes a simple puncture of the sac will suffice, the synovia diffusing itself freely into the surrounding cellular tissue under gentle pressure of the finger. It is necessary, however, that the effect of this pressure should be tried before the knife is withdrawn, for sometimes the cyst is divided by partitions into separate cavities, so as to require, in order to leave no pouch unopened, a freer incision of its walls in various directions, which is to be made without enlarging the orifice of the skin, and without pricking the tendon or dividing the superficial veins and nerves. If, under these circumstances, the tumour does not subside, and especially if there is some effusion of blood in the cyst, it will I believe be better, for the reasons given in the next article, to make a free external opening at the place of puncture, so as to empty the contents of the sac, or to make a second puncture at any point of the tumour which has not subsided. The limb must be kept perfectly at rest for some time, and surrounded with a compress and bandage, and, if necessary, some cold astringent or evaporating lotion applied.

Distension of the sheaths of the tendons about the fingers, hand and wrist, of an entirely different description, and requiring operation, is sometimes met with. In the case of a gentleman of this city afflicted with granular degeneration of the kidneys, whom I attended in conjunction with Professor Dunglison, we found in addition to the general dropsical tendency, a bursal swelling or hygroma on several of the flexor tendons of the foot. The accumulation of the fluid became so great as to cause much lameness and pain, and finally produced a luxation of the corresponding phalanges from the metatarsal bones. The bones ultimately became fixed in nearly a vertical position, from the flexor tendons sliding over their grooves and getting on the back of the metatarsal bones, so as to be converted into extensors. On opening the bursal sheath, the cellular and fibrous tissue on its outer surface was found to have undergone the lardaceous degeneration, for the

removal of which caustic potash was used, with the effect, finally, of obliterating the cyst.

In paronychia, we not unfrequently find the sheaths of the flexor tendons of the fingers involved, so as to become greatly distended by synovial fluid. If this affection be not treated sufficiently early by free incision, in place of the synovial fluid we may find the sheaths filled with pus, attended with great aggravation of the accompanying symptoms. The sheaths of these tendons are commonly, though not always, separated by transverse septa from the synovial covering of the same tendons in the palm and wrist. Where the septa either do not naturally exist, or have been broken down, we find in extreme cases the same collection of serous or purulent fluid forming tumours in the hand and wrist, and requiring to be freely opened. In such instances, it becomes necessary, after the operation, to keep the fingers extended for a considerable period on a splint, in order to prevent the muscular fibres, which become influenced by the disease, from retaining them permanently flexed. There is, however, always a risk of such a result after these operations, of which the patient should be apprised.

In a case that I attended in consultation with Dr. Spackman, of this city, in which a poisoned wound on the ball of the thumb had been followed with immense swelling of the hand, suppuration in the theca of its long flexor tendon, and an extensive abscess deep in the palm of the hand, I was enabled to effect a cure without deformity, by laying open the sheath of the tendon on the thumb, and passing a curved probe-pointed bistoury along the tendon up into the palm; the incision of some resisting fibres with the bistoury at the end of the track, allowed the pus from the palm to gush out through the external opening.

Hydatiform cysts,—*synovial cysts enclosing a number of small white bodies*.—In many instances on the back of the wrist and ankle, and on the palmar surface of the fingers, but more especially in the former position, the synovial cysts, which have already been described, are found to contain a great number of small white semi-transparent bodies, of a shape that is very variable, but frequently resembling that of a small bean. In two cases of this kind for which I have operated, (in both of which the swelling was on the back of the carpus,) I discharged by incision in one over a hundred, and in the other a still greater number of these bodies; some of these were three-eighths of an inch in length, and others, so small as hardly to be separately distinguished, were matted together in a heap. Double this number have frequently been met with. Mr. Ferguson speaks of having removed several hundred from an oblong swelling of the sheath of one of the flexor tendons of the finger. The mode of development of these bodies, and of similar ones found in the bursæ mucosæ, is believed in a great degree analogous to those of the joints. It has been assigned to the effusion of lymph, ultimately converted into a semi-cartilaginous state, like the productions found on the pleura and arachnoid. But the opinion of Velpeau, that they arise from effused blood, is certainly in a great many instances that which may be considered the true one. I have known ganglions on the wrist previously free of these bodies, present the evidence of their existence in great numbers after a severe accidental contusion of the part, or an unsuccessful attempt to cure them by incision, which had left the cavity around the tendon filled with blood. It has been supposed that the blood by coagulating in the cavity, and becom-

ing divided into many portions by the friction of the tendons, gets macerated in the serum so as to lose its colour, and in the state of fibrin either by becoming attached to the membrane, or simply floating in the serum, takes on an obscure sort of growth. This, however, is but an hypothesis, though a plausible one. Dupuytren believed them hydatid cysts, capable of motion; but in this opinion he was unquestionably mistaken. Cysts on the back of the wrist or ankle containing these bodies usually belong to the class of double tumours already noticed, one of which is found above and one below the annular ligament, under which they communicate together. By alternate pressure on these tumours we displace the fluid and the bodies floating in it; this gives a sensation of something slipping, with an indistinct sense of crepitation, forming the diagnostic mark of the existence of these little cartilages. The only method of effecting a radical cure in these cases consists in opening the cysts, discharging the cartilages, and causing the obliteration of the cavity. The extirpation of the cyst, from the manner in which it is connected round the tendons, would be an operation as difficult as it might be dangerous. The usual method of proceeding is to open the cyst above and below the annular ligament by an incision parallel with the tendons, and after emptying it, introduce into the cavity a mesh of charpie or a piece of linen, which is to be removed at the end of the second day, so as to cause it to suppurate and close by granulation. But this plan I have found liable to be followed by greater or less stiffness about the joint, and in more than one instance reported, it has been attended by such extensive sub-aponeurotic inflammation of the hand and fore arm, as to cause death. In the two cases referred to on the last page, I made an incision under the skin, (obliquely, in order to avoid the introduction of air,) through which I forced the bodies by gentle effort; the surfaces of the cyst were then compressed together, with a view of obliterating them, with a stout leathern splint buckled tightly round the wrist. In one of the cases, success was immediate; in the other, there was a re-development of the cartilages, requiring a second and third operation, leaving in the end a fibrous knot upon one of the tendons. Dupuytren passed a seton through the cavity, but was compelled to abandon the practice, in consequence of the excessive inflammation it produced.

HYGROMA.—ENLARGED BURSÆ MUCOSÆ.

Dropsy of the Bursa.

From causes analogous to those above mentioned in reference to the other synovial tumours, but especially from contusion, do we have a dropsical accumulation of the synovial fluid in the bursæ. It may occur in any of the numerous bursal sacs, but those of the knee and elbow are the only ones in general which require any operation beyond that of simple puncture for the removal of the fluid. The former is found between the skin and the ligament of the patella—the latter between the olecranon process and the skin, and is much less frequently the subject of disease. In both instances a prominent, obscurely fluctuating tumour is observed, often from the effect of pressure accompanied with a slight change of colour in the skin. Sometimes the tumour consists of a single cyst; but more often, according to my own experience, especially in hygroma of the knee, (housemaid's knee,) of a series of cells in

the interior of a common cyst, filled with a fluid so viscous and gelatinous as to render its discharge by puncture slow and difficult.

Treatment.—The principle of cure consists not only in removing the secretion, but in obliterating the sac, so as to prevent effectually the reproduction of the tumour.

Puncture and injection.—A simple puncture will seldom suffice for a cure. I succeeded completely, five years ago, in the case of a Methodist preacher, in effectually curing a tumour of this description below the knee, by puncturing the sac, lacerating the enclosed cells with the point of the knife, pressing out the glairy fluid, and injecting into the cavity tinct. iodi. diluted with four parts of water. Pressure was also applied subsequently by the aid of a compress and bandage. This plan of treatment, which is on the same principle as the modern practice in hydrocele, has lately been employed to a considerable extent by M. Velpeau, and is one deserving of much confidence.

By the seton.—It is the custom among some practitioners, when the tumour has become troublesome from its size, as well as sore from continued pressure, to puncture it and introduce a seton through the cavity of the sac. A cure may unquestionably thus be accomplished, but it is usually tardy, painful, and attended by profuse suppuration.

By shaving off the anterior wall.—M. Masnier* has advised, in these and all other encysted tumours, to shave off the anterior half of the sac, after having previously opened and dissected off the skin; or, if the tumour be small and prominent, shaving off with the point of the sac the corresponding portion of integument. But this is not a method which has received the sanction of general use.

By ablation.—The tumour has in some instances been completely dissected out. This is an effectual means of cure and in many instances the most advisable; but where the tumour is large, and the walls, as is commonly the case, firmly adherent on their outer surface, the proximity of important parts renders it a proceeding accompanied with some danger. Velpeau reports two cases of death following this method of operation. Sometimes, from habitual pressure on the surface, suppuration takes place spontaneously in the cavity of the sac; the abscess thus formed opens by ulceration, and is commonly followed by a cure. Foreign bodies of the same semi-cartilaginous character as those above described are occasionally met with in the bursæ, and require a similar method of treatment.

ANCHYLOSIS.

There are two forms of ankylosis of the joints. 1. That which is called *true* or *complete*, resulting from causes that have acted on the interior, of the joint; such as fractures running into the articular cavity, extensive wounds of the joint, abscesses, erosion of the cartilages or ends of the bones, either of which may produce such an ossific union of the articular surfaces, as to prevent all motion between them. 2. That which is called *false* or *incomplete*, where the abnormal junction between the ends of the bones, instead of being ossific is ligamentous; or is the result of the adventitious attachment of portions of the synovial membrane, of the contraction of the muscles or ligaments or cellular tissue

round the joint, or of extensive cicatrices following burns and ulcers. In fact, the remote causes which may give rise to false ankylosis are exceedingly numerous; but our object at present is to consider the first variety, which, though far less frequently met with, becomes more directly the subject for consideration in this place, where we are treating of the operations upon the bones themselves.* Each of the joints may be affected with ankylosis; but in those of the hinge-like form, as the knee, elbow, ankle, and jaw, it is most frequently observed.

The *diagnosis* between these two forms of the affection is generally though not always easy, and is of the first importance as regards the treatment. In true ankylosis, the joint is solid, perfectly immovable, and all the attempts to produce motion are unattended with pain; and not unfrequently we are enabled to feel through the integuments the uneven surface of the callus which has united the articular faces of the bones. In false ankylosis, on the contrary, there is in most cases some degree of mobility between the ends of the bones. Occasionally, however, the stiffness and rigidity of the surrounding parts are so great even where there is no bony union, as to render the joint perfectly inflexible. But here from the previous history of the case, especially if the affection has had its origin exterior to the cavity of the joint, and from the fact that in false ankylosis the joint usually becomes swollen and painful after active efforts have been made in order to produce motion, we are enabled to decide with a great degree of precision in regard to the actual state of the articulation.

There are three methods of remedying the inconveniences resulting from the solidification of the joint, which constitutes true ankylosis.

1. To re-establish the movements of the joint, by rupturing the adventitious junction between the bones.

2. To establish a new point of motion by the creation of a false joint.

3. To place the limb in a new position by taking out a wedge-shaped portion of bone, when it is ankylosed in a direction that renders it inconvenient or useless.

Rupture of the ankylosis.—No surgeon of experience can have failed to observe cases where an ankylosed knee, elbow, wrist or finger, has had its movements restored to a greater or less degree by an accidental rupture of the new bond of union, the consequence of a fall, or some external violence. The results in these cases, where in all probability the bony union has been but very partial, such, for instance, as the adhesion of the sides of the patella to the condyles of the os femoris, have led surgeons to imitate the process, by producing a forced rupture of the uniting medium between the ends of the bones. The consequences of these attempts, have not, however, been such as to sanction the adoption, especially as regards the large joints, of a highly dangerous experimental operation, for a mere deformity, which does not in itself compromise life. M. Louvrier lost five patients out of twenty-one by this process for straightening bent and ankylosed knee-joints, and in some of those that survived, the violence employed was followed by excessive inflammation of the surrounding parts, luxation of the knee backward, and a secondary ankylosis at an angle more or less obtuse. He has, however, in

* The surgical treatment of false ankylosis will be considered under the head of Subcutaneous Operations.

* Theses de la Faculté de Paris, 1803.

some cases, obtained complete success by rupturing the attachments; and instances no doubt may be occasionally found where the union of the bones is so partial, as to justify the attempt. It will be difficult, however, to determine beforehand the cases in which it may be employed with impunity from those where its application would be highly dangerous or fatal.

The stretching apparatus of Louvrier is thus arranged:—A linen roller bandage is first fastened tightly around the knee, in order to prevent by its pressure any resistance from the contraction of the muscles, and should embrace both the lower part of the thigh and the upper part of the leg. The inequalities of the surface of the latter are to be filled up with cotton wadding, which is to be sustained by another bandage rolled over it, so as to give the leg the shape of a cone, the basis of which is at the knee. The anterior and posterior surface of the thigh and leg are then covered with hollow splints of strong leather, (which should be fastened with straps,) in order to protect the soft parts against the pressure of the apparatus. The foot is then covered with a woollen stocking and a leather half boot, secured in like manner to the leg by straps. On the inner surface of the heel of this boot is a strong screw with a perforated head. These preparations completed, the patient is placed upon a table, with a pillow for his seat, and with his back leaning against the wall. The diseased extremity is now to be placed in the apparatus. This consists of an oblong box, from which the cover and end pieces have been removed, provided at its foot end with a horizontal beam, turned by a crank on its outside. Around this beam is wound a strong cord, of the thickness of a quill, one end of which is fastened to the screw in the heel of the boot. A very wide leather splint, reaching from the middle of the thigh down to the middle of the leg, is then placed on the posterior surface, so as to surround about two-thirds of the circumference of the extremity. This splint is composed of two pieces, with a circular joint at each condyle, so as to allow the lower part to follow the movements of the leg. Four iron bars, rising perpendicularly from the four corners of the joint, support a metal frame, below which is attached a leathern bolster, to be applied upon the anterior surface of the knee. Through this plate and bolster, the downward pressure upon the knee is made, by means of a cord that runs from the metal frame and turns round a pulley to the beam, around which it is tightened by turning the crank. The leg, as it lies on the box, forms with the bottom of the latter a hollow triangle, the apex of which is in the ham. It is now the object of the surgeon to press down the knee, until its posterior surface touches the bottom of the box. This is accomplished by turning the crank of the machine so as to tighten the cords; one of which pulls out the foot and stretches the leg, and the other, by means of the frame and bolster, effects a powerful downward pressure on the knee. In about thirty seconds, the operation is usually completed. The pain during this time is excessive, and is compared by the patient to that caused by the extraction of a tooth, but soon ceases on the removal of the apparatus, which is to be taken away immediately after the operation. At the last step of the process, a crackling sound is heard, which denotes the forcible separation of the parts. If the rupture of the ankylosis has been complete, the leg may be moved freely and without pain. The patient is then placed for two hours in a warm bath; and the parts are entirely freed from all local pres-

sure. The day following, narcotic poultices are applied about the knee, and a simple support given to the limb, in order to prevent the involuntary contraction of the muscles.

2. *Formation of an artificial joint.*—This method, for which we are indebted to the ingenuity of Dr. John Rhea Barton, of this city, has been applied as yet but to the ankylosis of a single articulation—that of the hip joint. It has, however, been suggested by this skilful surgeon, that it might likewise be found applicable to similar affections of the lower jaw, knee, elbow, fingers, and toes, when the muscles of these respective articulations remain uninjured. The method consists in the uncovering of the bone at or near the diseased point, dividing it across with the saw, and subsequently moving the lower portion from time to time upon the upper, to prevent a solid reunion of the divided parts. By this mode of proceeding, there is the same disposition of parts for the formation of a false joint, as we often find leading to that result in fractures, where the bones are not kept sufficiently at rest. Under such circumstances, the two opposing surfaces of bone may be expected to unite by flexible ligamentous matter, or become smooth and polished by the friction: the lower fragment, in the latter case, rounding itself into the form of a head; and the upper hollowing itself more or less into the shape of a cup, in which the lower fragment plays; the periosteum and surrounding cellular tissue becoming condensed and thickened, so as to perform the office of a fibrous capsule, and the muscles modified to a certain extent, to accommodate themselves to the new articulation.

For ankylosis of the hip. (*Process of Barton*, Pl. XXII, fig. 3.)—The ingenious idea of remedying this deformity by the establishment of an artificial joint, was practised by Dr. Barton, in 1826. A similar operation was repeated four years subsequently by Dr. J. Kearny Rogers, of New York; the two constituting the only instances in which it has yet been attempted on the living subject. The patient of Dr. Barton was a young man twenty-one years of age, in whom the thigh was held immovably bent at a right angle with the pelvis, and the foot turned in rotation inwards. A crucial incision was made over the projecting portion of the trochanter major, the vertical division of which was seven inches in length, and the transverse five. The four laminæ thus formed were dissected and turned back, and the fascia freely opened. The muscular fibres were then detached from over the trochanter by turning the scalpel sideways, so as to allow the two index fingers to be passed freely round the neck of the femur, till they met on the opposite side. With a strong straight saw the bone was then nearly divided through the upper part of the great trochanter and part of the neck of the bone. The operation lasted but seven minutes, and no artery was opened that required to be tied. The limb was then drawn to its proper position, when the undivided portion of the bone separated with a snap. The wound was closed with a few points of suture, and the extremity secured in the fracture apparatus of Desault.*

On the twentieth day after the operation the inflammatory symptoms had in a great measure subsided; some slight passive movements were then made with the limb, in directions natural to the healthy joint, which were cautiously repeated from time to time.

* North Amer. Med. and Surg. Journal, April, 1827.

By the sixtieth day the wound was completely healed; the patient was able to stand erect with the aid of crutches, and could advance his limb exclusively by muscular exertion. At the end of four months he was able to walk without apparent lameness, and all the movements of the limb were executed without pain. The foot could be carried twenty-two inches forward, twenty-six backwards, and twenty outwards, and could be rotated inwards to the extent of six. The patient enjoyed the use of his artificial joint for a period of six years, at the end of which time, from causes attributable to intemperance and repeated falls upon the hip, the new joint became permanently ankylosed.

The operation of Dr. Rogers was equally successful, and his patient left the hospital at the end of four months, apparently with a perfect use of the new joint, as he could walk with ease by the

assistance of a cane. The new joint, however, in the end became ankylosed in this case, as in that of Dr. Barton. In consequence of the shortening of the limb of the opposite side from fracture, Dr. Rogers, instead of making a simple section, removed a wedge-shaped portion of the bone, in order to render the relative length of the two limbs more equal.

In place of dividing the bone after section of the soft parts, as above described, it has been proposed, by M. Louvrier, to produce directly by mechanical means a fracture of the neck of the thigh bone, a measure which he believes less dangerous than the former, and affording equal facilities for the formation of a false joint. But provided it were possible to succeed in fracturing the bone at the desired point, there would be such danger by this method of doing violence to the surrounding parts, that it can offer no proba-

PLATE XXI.—OPERATIONS UPON THE BONES.

(Fig. 1.) RESECTION OF THE ENDS OF THE FRAGMENTS IN UNUNITED FRACTURE OF THE OS HUMERI. (*Process of the Author.*)

The operation is represented on the left arm, which is raised at the shoulder joint and depressed at the elbow, so as to cause the bones to protrude at the wound. The limb is seen on its outer face. The incision has been made in the intermuscular space between the brachialis anticus and the triceps muscles, just below the insertion of the deltoid. The parts are slightly dissected, so as to render the anatomy clearer than it would appear during the operation. In other respects the operation is precisely the same as one performed by the author for false joint at this part of the arm.

- a. Insertion of the deltoid muscle, which is exposed along the inner border of the incision.
- b. Outer edge of the brachialis anticus.
- c. Triceps extensor cubiti muscle, the fibres of which have been divided across at the upper part of the wound, to give a better view of the false joint.
- d. Lower end of the upper fragment of the bone, which has been turned partly out of the wound, after the section of the ligamentous matter which had connected the ends of the two fragments together.
- e. Upper end of the lower fragment. The ligamentous matter is represented as removed from the end of the bone, showing that it is covered with a compact lamina like the extremity of a bone after amputation.
- f. Musculo-spiral nerve, winding very obliquely in its groove round the outer face of the bone; it is, unless great care is exercised, liable to be cut in the operation.
- g, h. Musculo-spiral artery and vein.
- i. A long narrow compress, used to raise the end of the bone and protect the soft parts below from the action of the saw or forceps, with which the rounded end is to be excised.

(Fig. 2.) INTRODUCTION OF THE SETON, FOR UNUNITED FRACTURE OF THE TIBIA.

In this case two incisions have been made on opposite surfaces of the bone, (which is supposed to have been obliquely fractured,) in the manner of Wardrop, and the seton has been carried through, after a perforation had been made with a trephine needle through the overlapping ends of the fragments. In the arm, or wherever the bones can be separated so as to obtain room, the common seton needle may be passed at once without previous incision.

(Fig. 3 and 4.) REMOVAL OF A LOOSENED AND NECROSED PORTION OF BONE FROM THE WALLS OF THE CRANIUM.

An incision in the shape of a T has been made, and the two angular flaps dissected up and reversed. The point of an elevator is seen insinuated under the edge of the dead bone, in order to raise it up and slide it outwards, so that it can be seized with the forceps and removed.

Fig. 4 is the piece of bone shown separate. It is rough and serrated on the edges from the action of the absorbents which have detached it from the living tissue.

Fig 2

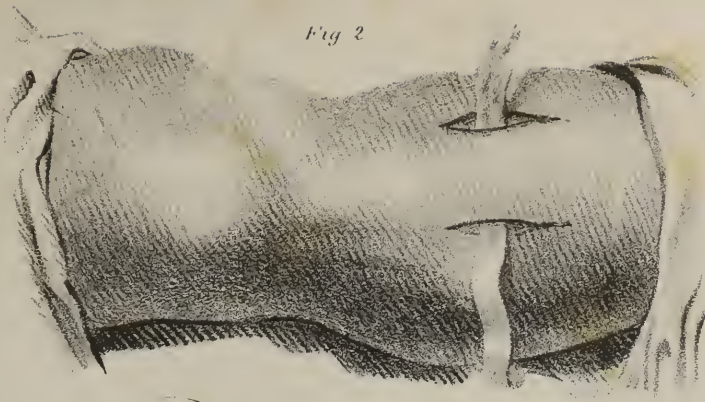


Fig 6

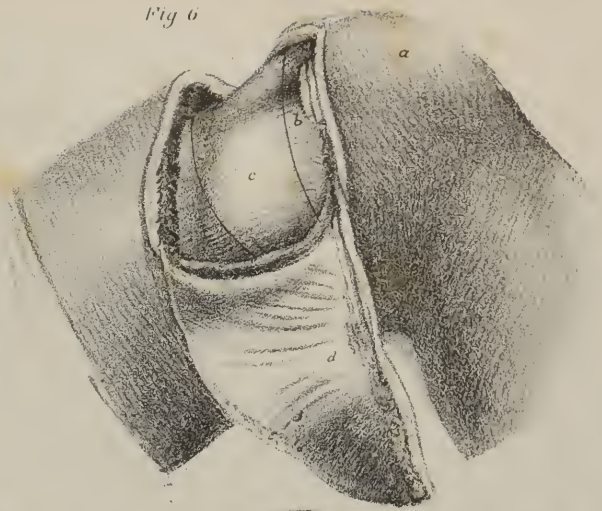


Fig 7

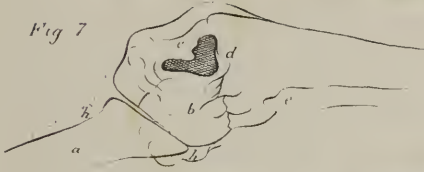


Fig 1

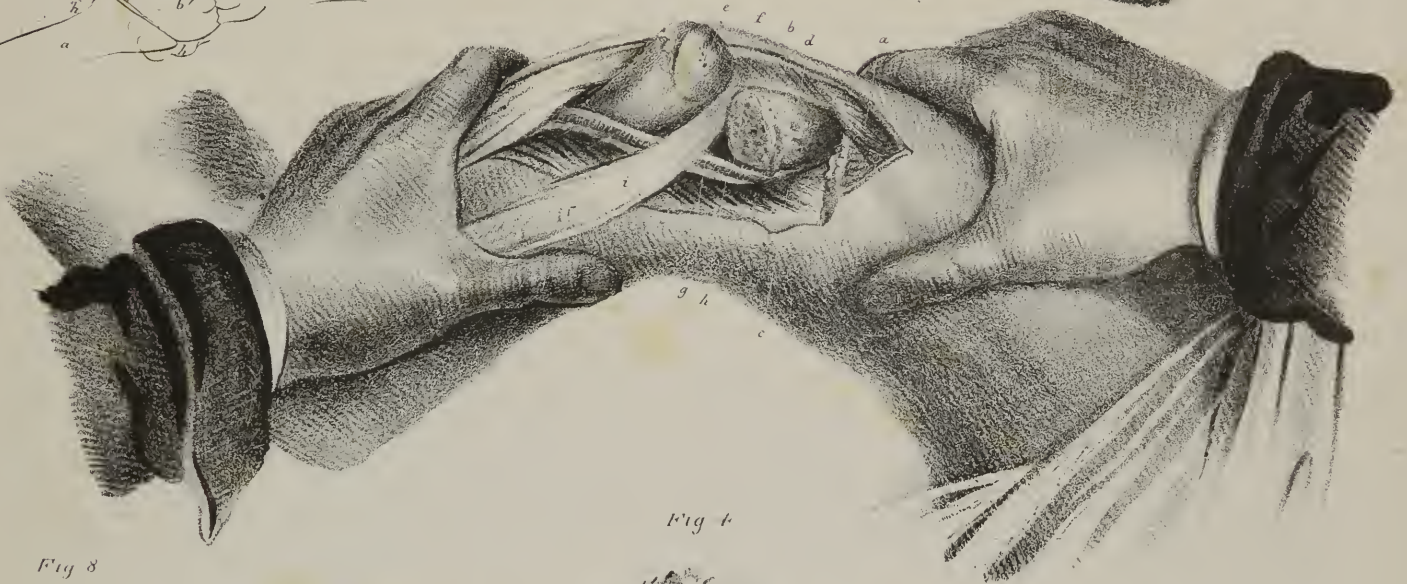


Fig 4



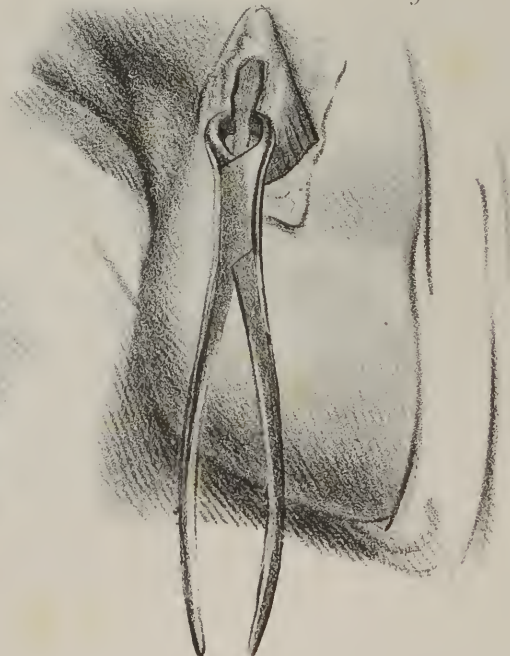
Fig 8



Fig 3



Fig 5



ble advantages to cause it to be compared with the neat and methodical section of the bone according to the plan of Dr. Barton. It would be rather more easy to divide the femur below the trochanter, but by this measure an all-important object would be lost—that of obtaining a new and solid articulation upon the pelvic bones, so as to re-establish the functions of the limb with the least possible shortening.

3. *Removal of a wedge-shaped portion of bone, for straightening a bent and ankylosed knee joint.* (Process of Barton, Pl. XXI. fig. 6.)—In bony ankylosis of the knee joint, when there is so much angular deformity as to render the leg a mere incumbrance to the patient, it was not till recently that any measure of relief had been proposed, save that of amputation. To Dr. John Rhea Barton* we are indebted for the introduction of a new process for the relief of this deformity, which in 1835 was successfully employed by him in the case of a young physician from the south. The process is as follows:—the object being to expose a portion of the anterior surface of the os femoris just above the condyles, and as low down as within half an inch of the patella, which will be found firmly adherent on the face of the joint. Two incisions are to be made across the femur, just above the patella; one commencing at a point opposite the upper end of the internal condyle, and the other two and a half inches higher and on the same side; both are to be extended over the bone till they meet on the opposite side, forming a sort of tongue-shaped triangular flap. This flap, consisting of the integuments, the tendon of the extensor muscles of the leg at its place of insertion, some of the fibres of the rectus and cruralis muscles, and a greater part of the vastus externus, is to be dissected up, with the fascia and muscles, from the sides and front of the bone, and turned over upon the leg. This flap in some instances will be found stiff and

* Vide Amer. Journ. Med. Sciences for 1838.

resisting, in consequence of the deposit of new bony matter in the sub-aponeurotic cellular tissue. The soft parts are next to be detached at the outer side of the femur, from the base of the flap towards the ham, by passing a knife over the circumference of the bone, so as to admit the use of the saw. A wedge-shaped piece is then to be removed from the spongy tissue of the head of the femur, by two sections with a saw, sloped so as to meet within a few lines of the posterior face of the bone, but not so as to divide it entirely across, for fear of injuring the vessels in the ham. The base of the wedge on the front part of the thigh must have a width proportioned to the degree of deformity that is to be remedied—say from two to two and a half inches. The leg is then to be pressed backwards, so as to cause a rupture of the undivided portion of the bone without disconnecting the fragments. No blood-vessel is likely to be wounded that will require a ligature. The wound is to be lightly dressed, and the limb supported on a splint having *an angle corresponding to that of the knee previous to the operation*. When sufficient time has been allowed for the asperities of the ruptured fibres on the back portion of the bone to become smoothed by softening and absorption, so that the pressure backwards cannot cause ulceration of the artery, the limb is to be somewhat straightened by substituting for the first splint another with an angle less obtuse. By thus varying every few days the angle of the splint, the limb is brought by degrees into a position nearly straight. To protect the popliteal vessels from all chance of pressure, two long bran bags are laid lengthwise on the splint, with a vacancy of four or five inches between them, (which is to be filled with carded cotton,) opposite the lesion of the bone. Protracted suppuration and constitutional irritation, such as are attendant on compound fractures, (to which the wound of the operation may be compared,) must necessarily be expected to follow, and during the treatment particular care should be ob-

(Fig. 5.) EXTRACTION OF A SEQUESTRUM, OR NECROSED PIECE OF THE CLAVICLE.

A quadrilateral flap has been turned down from over the bone. The shell of new bone, or *involutum*, has been opened with the cutting pliers, so as to allow the loosened *sequestrum* to be grasped with the forceps and withdrawn.

(Fig. 6, 7 and 8.) REMOVAL OF A WEDGE-SHAPED PIECE OF BONE FOR TRUE ANCHYLOSIS OF THE KNEE JOINT. (Process of Barton.)

- a. Patella, adhering to the face of the condyles.
- b. Tendon of the extensor muscles, cut off near its insertion on the patella.
- c. Lower end of the femur; the two black lines crossing the bone meet together a little short of the posterior surface of the bone, and indicate the two tracks of the saw by which the wedge-shaped piece is removed.
- d. The tongue-shaped flap of integument, muscle, and tendon, raised by two semi-oval incisions, and reverted on the inner side of the knee.

Fig. 7 is a sketch illustrating the manner in which the limb is made straight, by gradually bringing up the leg, so as to throw the knee upwards till it effaces the space made by the removal of the wedge-shaped portion.

- a. Femur.
- b. External condyle.
- c. Adherent patella.
- d. Head of the tibia.
- e. Fibula.

Fig. 8 represents the limb in its state of angular deformity.

g. Is the outline of the wedge of bone removed. The other references correspond to the same parts as in fig. 7.

served, that in straightening the limb the lower fragment be not allowed to slide backwards, so as to shorten the leg, and render it nearly impossible to give the extremity the requisite degree of straightness.

Four months after the operation, the patient of Dr. Barton was able to stand erect, with his feet in their natural position; at the end of eight, he could mount his horse with facility and walk with ease, notwithstanding the loss of motion at the knee, from forty to fifty miles a day.

The same procedure has been repeated by Professor Gibson on a patient in the Philadelphia Hospital; this, and the former case, constitute the only instances, within my knowledge, for which this truly valuable American method for the treatment of ankylosis has yet been employed. In fifty-six days after the operation in the second case, there was firm union at the place of section; and though the thigh was shortened about an inch, the limb was nearly straight, and the patient could sustain himself upon it with ease.

COMPLICATED FRACTURES AND LUXATIONS.

Occasionally, these affections call for the performance of some specific operation.

1. *In extensive laceration of the flesh and skin*, with projection of the bone, occurring either in comminuted fractures, or compound fractures and luxations. In such cases, if the projecting fragment or the head of a protruding bone cannot be easily reduced, the wound should be enlarged by an incision, and a subsequent effort made to replace it. If this fail, the end of the bone is to be cut off with a saw, or a pair of strong-cutting forceps. The bones are then to be adjusted, and the wound treated so as to reduce it as much as possible to the state of simple fracture.

2. *Where the fracture is attended with the separation of splinters or scales from the bone.*—If the fragments are completely or nearly loosened from the bone and driven off into the soft parts, so as to be readily observed from without, an operation is required for their removal. An incision should be made opposite the irritating body, at the point where the bone is most superficial, selecting the intermuscular spaces when it is possible, and avoiding the side upon which the great vessels are located. The fragments are then to be removed with the forceps. Sometimes the splinters or scales are firmly attached to the periosteum by one end, while the other is lodged in the muscles, and will require to be loosened with the knife before they can be twisted out with the forceps. Simple fissures or splintering of the bone, without displacement of parts, call for no operation, as they readily become consolidated by the subsequent effusion of callus, under the ordinary plan of treatment for fracture.

3. *Where there is laceration of the vessels and nerves.*—When the vessels are lacerated, the different means of arresting hemorrhage suited to the peculiarities of each case, already noticed, have to be put in requisition. If the branches of the nerves be partially torn and exposed, they should be divided completely across with the bistoury. But extensive injuries of this description indicate the necessity of immediate amputation, a subject which will be hereafter considered.

PSEUDO-ARTHROSIS.—FALSE JOINT.—UNUNITED FRACTURE.

Varieties.—Fractures in which no bony union has taken place, may from the facts revealed by dissection, with propriety be divided into three classes. 1. Those in which the ends of the fragments, rounded and thinned by the action of the absorbents, are connected by an intermediate fibro-ligamentous tissue. This constitutes by far the largest class. 2. Where the end of one of the fragments has become rounded into a head, and the other converted by the constant motion of the parts, and the thickening and condensation of the surrounding tissues, into a cup or socket; both portions being surrounded by an adventitious capsular membrane, and lined by a new-formed synovial tissue. 3. Where the fragments have not been brought into opposition, but are kept separate by a portion of muscle, or a detached or necrosed piece of bone.

Causes.—The cause of the non-union in regard to the third variety, is sufficiently obvious. In respect to the first and second, it depends upon a number of circumstances very different in their character; and in some cases the accident occurs in despite of the most judicious treatment, and where no apparent cause can be assigned for the want of bony union. Among the most common causes, may be placed a mal-adjustment of the ends of the bones, imperfect support from the splints or other dressings applied, indolence on the part of the patient in keeping the limb at rest, meddlesome interference of the surgeon by too frequently changing the dressings without cause when they have once been properly adjusted, some morbid alteration of the bone, as that of caries or necrosis, the development of hydatids in its cavity, advanced age, or an impaired or exhausted state of the constitution. Sometimes, even after the bony matter has been deposited so as to unite the bones, it has been removed by absorption, leaving only a flexible cartilaginous bond of union.

Remarks.—The period within which we may expect a perfect consolidation of a broken bone to take place by the usual method of treatment, varies so much in regard to different individuals, as to be scarcely subject to any general rule. Nevertheless, we may ordinarily consider that a false joint has been formed, when, after the lapse of six months from the occurrence of the fracture, the fragments still remain movable at the point of injury.

False articulations have been observed in most of the bones; but they are more frequently met with in those which are most movable, as the humerus and the lower jaw. In fracture of the neck of the thigh bone within the capsule, where bony union in general is not to be expected, a false joint near the former centre of motion may be viewed as the best result that can follow. In most other instances, the integrity of the bone, by which it serves as a lever for the muscles to act with, is destroyed; and the limb to which it belongs (if it occur on an extremity), becomes nearly useless. But cases may occur, as rare exceptions to the general rule, especially where two bones are associated in nearly similar offices, as in the forearm and leg, in which an attempt on the part of the surgeon to solidify the false joint would be most injudicious. One of this description occurred in my service two winters ago at the Philadelphia Hospital. A man from the west had received in a fall a shock on the forearm, which dislocated the radius and carried it upwards on the humerus, and at the same time produced a fracture of the ulna about two inches and

a half below the joint, with considerable angular displacement; the lower fragment being brought up in close contact with the radius. No attempt at reduction was made; the limb in its deformed condition being merely put up in splints. The consequence was that bony union took place between the ulna and radius at the point where they come in contact, and a false ball and socket joint formed between the broken ends of the ulna. In flexion and extension, both bones moved together as far as they were permitted by the end of the radius resting on the humerus. In pronation and supination, which was very well performed, the radius and lower fragment of the ulna moved together, the latter rotating in the new formed articulation. Under such circumstances, the solidification of the false joint would have impaired to a great extent the utility of the limb; and the result here accidentally produced indicates the propriety of attempting to effect some analogous artificial means of relief in certain states of deformity and loss of use of the forearm, that occasionally arise from ill-treated fractures.

Treatment.—The general as well as the local measures of treatment, must vary according to the causes which have led to the defect.

1. *Of the local measures.*—It is here only necessary to note briefly the more important of the multitude that have been devised. No one of these in all cases being entirely sufficient to accomplish the object desired, it becomes advantageous to combine them, or try them in succession, according to the degree of action which they are capable of exciting in each case.

2. *Friction of the ends of the bones.*—This process, which is as old as the time of Celsus, consists in rubbing forcibly together the two fragments in order to excite a degree of inflammatory action that may lead to the deposit of earthy matter in the new tissue. This procedure is only applicable where the ends of the bones do not overlap, when there has been a mere transverse fracture, and when it is attempted at so early a period,—say six, eight to ten weeks after the injury,—that the false joint cannot be considered as fairly formed. The limb is then to be done up in splints, or what answers admirably well, the immovable apparatus prepared with dextrine or starch, and kept perfectly at rest for two or three weeks. After this period it is to be re-examined, and the measure, if it has been at all successful, repeated as before. If not, some of the succeeding processes are to be applied.

Compression.—A method somewhat analogous to the above was introduced by White, and has been occasionally found very advantageous. It consists in applying round the fractured limb a strong support,—such as that of an envelop of stout leather, well padded, and firmly secured with straps and buckles,—the patient to use the limb as much as possible, and if it be the lower extremity, even to move about upon it. As soon as a sufficient degree of action is provoked at the place of injury, as manifested by soreness and swelling, the limb is to be kept completely at rest, as directed after friction of the ends. Simple compression of the ends of the bones together, by the fracture apparatus, while the limb was kept at rest, has succeeded in two cases in my hands, as late as the third and fourth months after the reception of the injury.

3. *Cutaneous irritants.*—The application of blisters frequently renewed, of caustic potash, tinct. iodine, and analogous substances

immediately over the point of fracture, has been much praised by Wardrop and others. It may be considered a useful process where the work of ossification proceeds slowly, and the bones lie superficial, as in the forearm and leg; but according to my own observation, has little effect, even in these cases, if not employed within six or eight weeks after the injury.

4. *Seton.* (*Process of Physick.* Pl. XXI. fig. 2.)—The use of the seton, for which we are indebted to the practical wisdom of the late Dr. Physick, is a measure which may be relied on with considerable certainty for the cure of false joint in the jaw and upper extremity. In the lower extremity, the results of its employment have not been equally successful. Extension and counter-extension having been made upon the limb, so as to cause a separation of the fragments, Dr. Physick passed the ordinary seton *needle* through the limb, traversing the interval between the bones—cautiously avoiding the track of the principal blood-vessels and nerves, and selecting the points at which the bone was least covered with flesh. A stout cord or a skein of silk, which has been previously attached to the eye of the needle, is then to be drawn through after the instrument. The wound is to be simply dressed, and the limb, after suppuration is established, placed in an appropriate fracture apparatus. The seton is then to be daily moved in the wound, and retained even for a year or more, if so long a time be required for the limb to become sufficiently stiffened by the deposition of callus to admit of its executing its usual movements. If the necessary degree of irritation is not maintained by the simple seton, it may be smeared from time to time with some stimulating ointment.

The first case of Dr. Physick was an ununited fracture of the humerus. At the end of twelve weeks the consolidation began, and at the termination of five months and a half, the cure was complete. Professor Horner, of this city, has employed the sail-maker's needle in place of the ordinary instrument for carrying the seton. This is less liable to divide important parts, and I have found it to answer well, particularly in fracture of the lower jaw. In the latter affection, it should be carried from the cavity of the mouth, downwards and outwards, through the integuments covering the base of the jaw.

Modification of Wardrop.—This gentleman has proposed to modify the method of introducing the seton where the bone is deeply seated, as in the upper third of the thigh, by previously dividing with a bistoury the soft parts over it, and introducing the needle inclosed in a sheath down to the bottom of the wound, when it is to be passed through as in the process of Physick.

Modification of Oppenheim.—This consists in the introduction of two setons, so that one shall come in contact with each of the ends of the bones. Both may be introduced at the same time, or the second a few days after the first. When suppuration is fully established they are to be withdrawn. By such means, this surgeon believes a sufficient degree of inflammation will be excited to insure a bony union without incurring the same risk of erysipelas and abscess, which have in some cases carried off the patient, when the seton has been maintained a long time in the wound. He does not consider it absolutely necessary that the seton should traverse the tissue between the bones, the same advantageous effects being produced when they are placed merely in proximity or contact with the periosteal covering of the ends of the bones.

The value of this opinion has not perhaps been as yet sufficiently attested in practice.

In some instances, it is found exceedingly difficult, if not impossible, to pass the seton, either in consequence of the obliquity or overlapping of the fragments, or from the risk of injury of important parts; and under such circumstances, Professor Ferguson observes, he has seen a needle or probe left sticking in the fissure between the bones, followed by all the benefit that could have been expected if a cord had been carried through in the usual manner. In those cases where the fragments are held asunder by a necrosed portion of bone or a piece of muscle, the use of the seton would probably be attended with no benefit.

Sommè's modification. Section of the fibro-ligamentous union by means of a wire.—In an ununited fracture of the femur, this surgeon pierced the limb from within outwards, with a long delicate trocar, grazing the inner surface of the end of the lower and the front portion of the upper fragment. The stilet was withdrawn and a silver wire passed through the canula, and left in the wound, after the canula was taken away. A second puncture was made with the trocar, but in the opposite direction, from without inwards and forwards, and brought out at the place of the first puncture. The end of the wire, which had previously passed through the limb, was again carried through the canula; this instrument was then drawn through at the inner side of the limb and removed. The loop of the ligature thus surrounded the false joint, including the bridge of muscle and skin between the two posterior punctures, which was divided across with the bistoury to let the wire down to the bones; the lips of the incision were then

brought together so as to unite by first intention. By gradually tightening from time to time the loop which embraced the ligamentous tissue, this was by degrees divided, and an effusion of callus followed, consolidating the fracture at the end of six weeks, so far as to justify the removal of the wire. Three months after the operation, the patient was able to walk.

5. *Acupuncture.*—M. Malgaigne has suggested, in place of the seton, to introduce a number of acupuncture needles through the fibrous tissue between the ends of the bones. The trials which have been made of this process do not, however, prove it to have been very efficacious.

6. *Cauterization of the ends of the bones. (Process of Green.)*—An incision through the soft parts having been made so as to expose the ends of the fragments, the fibrous tissue uniting them is to be divided with the knife, and each end rubbed with a cylinder of caustic potash, till it becomes of a black hue. Especial care must be taken to protect the surrounding parts from the action of the caustic, which is to be applied in the depth and without turning out the bones through the wound. Earl has advised, in order to render the process more efficient, to previously scrape off the fibro-cartilaginous, or fibro-ligamentous covering of the ends of the bones, and apply the caustic directly upon the osseous tissue. Some operators have satisfied themselves with merely cutting down and scraping the ends of the bone. Numerous instances of the successful application of the caustic are recorded. The process is not, however, unattended with danger, as the fracture is rendered compound by the incision through the soft parts; and though rather less likely to produce severe constitutional

PLATE XXII.—OPERATIONS ON THE BONES.

(Fig. 1.) REMOVAL OF AN EXOSTOSIS, OF THE EBURNATED SOLID KIND, FROM OVER THE LAMBDOIDAL SUTURE.

The tumour was of a globular form, and projected for about an inch above the bone. It was divided vertically in two lines by the saw, so as to render its removal with Hey's saw more easy in three separate portions. One portion has been removed, and the saw is shown in the act of dividing the middle part.

(Fig. 2.) REMOVAL OF A TUMOUR OF THE SAME DESCRIPTION FROM THE UPPER THIRD OF THE HUMERUS.

- a. A triangular flap of the whole thickness of the deltoid has been raised between two incisions which run down parallel with the fibres of the muscles. The flap is reverted toward the shoulder so as to expose the diseased surface of the humerus.
- b. A wooden ruler, which is placed on the inner side of the tumour so as to press inwards the biceps muscle and the brachial vessels out of the way of Hey's saw, with which the tumour is divided at its connection with the arm bone.

(Fig. 4.) FORMATION OF AN ARTIFICIAL JOINT, FOR ANCHYLOSIS OF THE ARTICULATION OF THE HIP. (*Process of Barton.*)

The patient is laid upon the sound side. A crucial incision has been made, with its centre over the trochanter major. The four flaps are dissected up and reverted. The bone, after being denuded in its circumference with the knife, has been divided nearly across with the saw, the section being made partly through the trochanter and partly through the lower end of the neck of the bone. The figure represents the last stage of the operation, when, after the section of the bone, the limb has been swung inwards in order to snap the thin portion left unsevered by the saw.

Fig 2

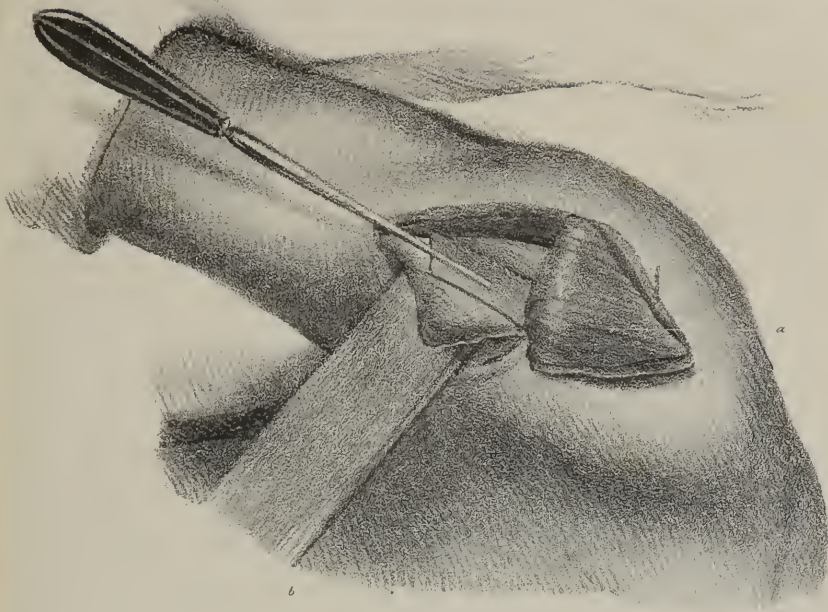


Fig 1

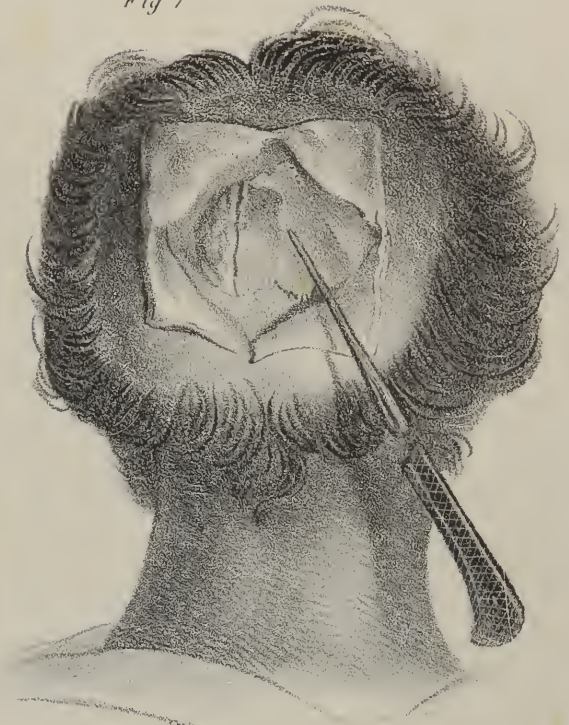


Fig 3



Fig 4



symptoms, it is not in general so certain a means of effecting a cure, (the fragments often overlapping so that the caustic cannot be made to act on the proper point,) as resection of the ends.

7. *Resection.* (Pl. XXI. fig. 1.)—The ends of the fragments are to be exposed as in the last process, by a longitudinal incision through the soft parts, and the intervening fibrous tissue divided across. The two extremities are then to be luxated, as it were, and made to project one at a time through the external wound, separating the adhering soft parts with the knife so far only as is absolutely necessary. The arteries are to be tied as they are cut. It will be found most convenient to protrude first the inferior fragment. The rounded ends of the bones are then to be removed with the saw or cutting forceps, after the manner of White. The bones are then to be replaced with their raw extremities exactly in contact. The subsequent treatment becomes precisely the same as in ordinary compound fractures, and the risk following the operation may be considered even greater than that attendant upon these affections; hence, when the thigh forms the seat of injury, it is so very dangerous that it should not be lightly undertaken.

Sometimes, when the fragments are deeply placed, one is found so short and so little movable, that it is impossible to cause them both to protrude. Under such circumstances, Dupuytren has found that the resection of the end of one of the bones suffices for the cure, if the extremity is put immediately in contact with the other fragment, which may at the same time be rasped or shaved, or irritated with caustic potash. When the fracture has been very oblique, it is necessary to remove a sufficient portion of the beveled extremities, to prevent any unnatural lengthening of the limb, which would, in the thigh or leg, be productive of considerable inconvenience. M. Flaubert, of Rouen, has proposed after resection to unite the ends of the bones by passing a wire in the manner of a suture through the fragments themselves. But the risk of necrosis, caries or abscess round the bone, and the constitutional disturbance consequent upon this process, would, it appears to me from what I have observed in one case, be so great as to render the measure as dangerous as it is unneeded. This proposition of uniting the ends of the bone in an ununited fracture by a wire suture is by no means new; the author having witnessed its performance many years ago in the Pennsylvania Hospital.

In the fore arm and leg, we select for the purpose of exposing the ends of the bones, the surface which is nearest the skin. In the thigh and arm, the longitudinal incision is made on the outer side of the limb, for the purpose of avoiding the vessels and nerves. In the arm, the incision is made in the intermuscular space, separating the outer margin of the biceps from the muscles on the fore part of the limb. At the middle part of the arm, the musculo-spiral nerve is found on the outer side of the limb, and between the triceps and biceps; it pierces subsequently the septum between these muscles, and must be carefully avoided by keeping it behind the line of incision. Its division, as shown in a case from the country, recently under my charge for resection of the ends of the bones, may be attended by permanent palsy of the extensor and supinator muscles of the hand. The previous operation, which had failed in this instance, consisted of the application of caustic potash to the ends of the bones.

In the thigh, the opening should be made between the biceps

flexor cruris and the margin of the vastus externus, where we may reach the bone, by following the intermuscular septum, without dividing a single muscular fibre. For the purpose of introducing a seton between the ends of the bones, Wardrop cut down along the external border of the rectus femoris, and brought out the needle at the external border of the vastus externus.

The method of resection for ununited fracture of the humerus is shown at Plate XXI, and fully explained in all its details.

By the use of Heines' saw (see Pl. XXXI.) the resection of the ends might readily be made without dislocating either fragment from its bed, and consequently diminishing the risk attendant on the operation. The section of the lower fragment, when protruded, is readily effected by the ordinary saw, as the limb can be rotated during its action, so as to make the division complete without disturbing the muscles on the other side. A strong pair of pliers, or a stout pair of dentist forceps I have found convenient in removing the pieces in cases where it was not deemed expedient to complete the section with the saw. A few touches of the knife may also be at times required to detach the adhering ligamentous shreds. In the arm, it is more difficult to make the complete section of the upper fragment with the saw without doing violence to the surrounding parts, in consequence of the resistance made by the muscles of the armpit, even when these muscles have been relaxed by carrying the arm upon the chest for the purpose of turning out the end of the bone. The bone, however, may be always deeply notched on its surface with a narrow saw, and the section may then be finished with Liston's cutting forceps, acting in the track of the former instrument. The wound should be carefully closed with adhesive strips covered with a compress, and the limb surrounded with a roller bandage, so as to effect, if possible, union of the lips of the incision by first intention. The limb should be kept perfectly at rest in a well adjusted fracture apparatus, and all pressure of the resected ends of the bones for several weeks carefully avoided, for fear of producing inflammation and suppuration in the cellular tissue of the bone.

Within a few months I have performed an operation of this description before the class of the Jefferson Medical College, in a case where, from causes wholly unconnected with the operation, death took place at the end of the fourth week, when the patient was about preparing to leave the city. The wound had healed completely by first intention, and no more pain or suffering had been experienced from the limb than occurs in ordinary fracture. The examination of the parts which I now have in my cabinet, shows a rigid thickening of the cellular tissue, aponeurotic layers, and neighbouring muscular fibres, about the place of fracture, which had given a considerable degree of solidity to the limb. The two ends of the bones were already coated over with a layer of tough gray matter, and adhered to each other by a tenacious filamentous lymph, which parted as the fragments were forced asunder.

DEFORMITIES FROM THE IRREGULAR UNION OF FRACTURED BONES.—VICIOUS OR DEFORMED CALLUS.

It is not unusual to meet with cases in which, from accident or mismanagement, the consolidation of a fracture has taken place, with shortening of the limb from the fragments riding over each other, or with a deformity in its direction owing to a mal-adjust-

ment of the ends of the bones during the progress of the cure, or from its becoming bent or curved by a premature use of the limb while the callus was yet soft and yielding.

Without going into detail in reference to the different theories of the formation of callus, it will suffice to state that it passes through different stages of development, from that of fibro-cartilage to bone; that it forms a temporary connection for holding the bones together, which, even when most consolidated, does not attain to the density of solid bone; and that the permanent callus, which is formed between the surfaces of the divided bone and when it becomes solidified forms the true bond of union, is the last portion developed. The period requisite for these progressive changes varies in different bones, but does not even in the larger consist of more than sixty or ninety days, beyond which period we may, under favourable circumstances, regard the union by permanent callus as having taken place. The longer, therefore, the callus has been in forming, the greater will be the difficulty of correcting the defects in the position of the bones.

In general the temporary callus does not, before the fiftieth or sixtieth day, acquire so much solidity but that it may be readily made to yield by pressure and extension; but it is most desirable that all deformities should be corrected as early as possible after they become known. Dupuytren has, however, furnished instances where the deformity has been removed by such measures, as late as one hundred and twenty days after the occurrence of the injury. Cases will present themselves that have been neglected for periods much longer than this, in which relief can only be afforded by other means more severe and hazardous, but which are nevertheless perfectly justifiable, when the use and symmetry of an important part are destroyed.

There are three principal methods for cure of the deformities referred to under this head.

1. *Pressure and permanent extension.*—If not more than a few weeks have elapsed from the time of the injury, we may be able at once to straighten simple angular deformities by the hands without the aid of machinery, especially if they are found in the fore arm or leg, the operator using his knee as the point of resistance; but if there be shortening from oblique fracture, it will in addition be necessary to bring down the bones by extension and counter-extension. Having once got the limb straight, the treatment is to be continued as in ordinary cases of fracture. But if a longer period has passed—thirty, forty, fifty, or sixty days—pressure and extension must be made gradually with an appropriate fracture or orthopedic apparatus, and repeated every second or third day, strict care being observed to retain, by the steady use of the instrument, what has been gained by the force applied. If the callus has become too solid to yield to these measures, it has been proposed to soften it previously by passing a seton through it so as to provoke a sudden inflammation, which is commonly attended with some softening of the new structure.

Use of the seton. (*Process of Weinhold.*)—In a case of fractured thigh of three months' standing, firmly consolidated with a great exuberance of callus, and with a shortening of two inches, this surgeon was so successful as to ultimately restore the limb to within two lines of its natural length. With a sort of *trepan needle*, mounted on a joiner's brace, entered through the soft parts an inch to the outer side of the femoral artery, he perfo-

rated the mass of callus. The needle was then carried out through the opposite side of the limb, dragging after it the ordinary seton. At the end of seven weeks the callus began to yield; and the common extension apparatus was applied.

2. *Rupture of the callus.*—This may sometimes be effected by straining the limb over the knee, and rupturing the new union as we would break a stick. Velpeau has proposed to place the deformed limb with its concavity upon a solid plane, while pressure is made suddenly and forcibly with the knee or hands on its convex surface. There is, however, always more or less danger of splintering the bone, or fracturing it at a new point, so that this plan, where much resistance is offered, is but little followed. It is considered better surgery under such circumstances, especially where there is a mere angular deformity, to endeavour to effect the object by the aid of machinery, properly padded and braced, so that the force shall be applied only over the new-formed union. A double inclined plane, truncated at the top, and opening with a joint at a similar angle with the limb it supports, answers the purpose nearly or quite as well as the complicated apparatus of *Æsterlen*, in which a pad, attached to a solid piece of board, is forced downwards with a screw, so as to press on the convex surface of the callus. *Æsterlen* has reported forty cases of success by this method of treatment.

3. *Section of the callus.*—This is the only means left for remedying a deformity that has resisted the judicious application of the preceding measures, or for the treatment of a thoroughly consolidated fracture. It consists in laying bare the surface of the callus by incisions, and, instead of breaking, dividing it across with a saw, or the gouge and mallet. It is the only method left for managing the confused solidification which sometimes takes place after fracture of the bones of the fore arm. It converts the deformity into the state of a compound fracture, and is attended by the same risk to the patient, and requires subsequently similar treatment with that affection. A judicious surgeon would not, therefore, attempt a cure by this means, except in cases where it was urgently indicated.

Process of Wasserfuhr.—For a fracture, in a child of five years, of the upper third of the femur of three weeks' standing with a salient angle at the outer side of the thigh and great shortening of the limb, this surgeon made a transverse incision over the prominent point, equal to one-fourth the circumference of the limb. The callus, exposed by the retraction of the divided muscles, was cut nearly through with a fine saw, and the separation completed by fracture.* The limb was then placed in an extension apparatus, and complete success is said to have followed the operation.

In many instances the American method of cure for ankylosis, by removing a wedge-shaped portion of bone, and subsequently straightening the limb, will be found available in relieving this class of deformities. This principle has been several times successfully employed; in one instance in a case of great deformity of the leg by Professor Mütter.† If in treating injuries of this description, the muscles on the concave surface of the limb have so shortened themselves as to refuse to yield readily on distension,

* The solid state of the callus at this early period is to be explained by the youth of the patient—the process of bony reunion taking place more rapidly in children than in adults.

† American Journ. Med. Sciences, April, 1842.

a section of their tendons, especially in the lower extremities, made as described in this work under the head of subcutaneous operations, may occasionally be attended with advantage.

EXOSTOSIS. (PL. XXII.)

The tumours bearing this name may be distinguished: 1. According to their original seat, which may be either between the periosteum and the surface of the bone, or between the medullary lining membrane and the cancellated structure. 2. According to their nature—as they are cartilaginous, eburnated, porous, or osteo-sarcomatous. 3. According to their form and size, whether they are styloid, rounded, pediculated, circumscribed, diffused, etc. The proper periosteal exostosis, formed on the free surface of the periosteal membrane (periostosis), as shown by Professors Albers and Rognetta, are first formed like epiphysis, though they become ultimately solidly attached to the bone on which they rest. To all of these varieties, surgical operations for their removal are by no means applicable. If they are in their forming state, fibrous, or cartilaginous, they need not be interfered with except they produce great deformity. If they have degenerated so as to become soft and spongy, as in growths from the walls of the antrum maxillare, nothing short of resection of the bones involved, or amputation of the member will suffice. Simple oblong enlargements on the surface of a bone are ordinary occurrences; and if no other inconvenience than slight deformity results from their presence, they should not be interfered with. Nothing in fact justifies their removal by operation, except that the tumour, from its great size or vicious direction, interferes with the functions of surrounding organs. Such as arise from syphilis, from scrofula (as is so common in children), and other constitutional affections, are curable usually by appropriate general and local treatment; and, if touched at all, cannot be taken away with safety till after the removal of the constitutional disorder.

Modes of operation.—The application of the actual cautery and caustic articles so much in use among the ancients, and still employed for a like purpose in farriery, is now abandoned in the treatment of these affections—surgeons limiting themselves almost exclusively to the employment of mechanical measures, and using the cautery only as a means of arresting hemorrhage after the operation, or destroying a portion which cannot be readily extirpated. If the exostosis is entirely cartilaginous, intermixed with plates of bone, and periosteal in its origin, it does not adhere at first very firmly to the bone, and may be prized off from it after having been exposed by incisions through the soft parts covering it. Large tumours of this description I have found readily removed from round the base and ramus of the lower jaw. If the tumour has become ossified, making a continuous structure with the bone below, it may, if pediculated, be detached by section with the saw, forceps, or chisel. If adherent by a large base, it must be separated in portions, either by several applications of the trephine, or divided perpendicularly in various directions with the saw, and the portions detached at their base with the cutting forceps, or the mallet and chisel. If the bone below be merely inflamed, vascular, and expanded in its areolæ, it may be left to the influence of general and local therapeutic measures, on the same principle that we would treat similar affections in the soft parts, when the offending cause had been removed. If there are

grounds for suspecting its degeneration, an exploratory perforation may be made with a trephine, after the manner of Dupuytren, in order to decide whether it will be necessary to proceed to resection or amputation. If the seat of the tumour be in the medullary cavity of a long bone, the soft parts are to be dissected off, the expanded shell of the bone laid open with the trephine, the mallet and chisel, a Hey's saw, or the cutting forceps, (the last answering well to enlarge the space after the opening has once been effected)—and the nucleus turned out from the cavity it occupies. The soft parts are then to be brought together, and a slip of linen interposed at the depending portion of the wound, so as to permit a free escape of the purulent secretion, and allow of the introduction of detersive fluid injections. In the after treatment I have derived great benefit from compression applied by the means of a roller, or of adhesive straps, as in Baynton's method for the cure of ulcers, which, though acting directly on the soft parts, exercise considerable influence on the bone.

Remarks. The mode of proceeding in the removal of exostosis will be more or less varied, not only by the nature and form of the tumour, but also by the character and peculiar arrangement of the parts which surround or support it. As these difficulties, as well as the means of surmounting them, cannot be subjected positively to any general rules, and as the latter must be founded upon the exigencies of each individual case, it will not be necessary to describe the process for the removal of these tumours in the various portions of the body. By reference to Plate XXII, the general method of proceeding will be well understood. The saw and the trephine will be found most appropriate in the removal of cranial exostosis, as the concussion attending the use of the mallet and chisel might injuriously affect the brain. In the removal of tumours deeply situated, the obvious necessity of protecting the neighbouring parts increases the difficulty of the operation; and it is in these cases when we act in a narrow space, that great advantage may be obtained from the use of a chain saw, or the different steetomes that have been devised, the best of which is that of Heine. In laying bare the tumour, the rules generally laid down for avoiding the vessels and nerves are to be carefully followed. In many respects the method of incision can be advantageously modified so as to spare more or less important parts, according to the nature of the case and the ingenuity of the surgeon. In an exostosis with a narrow base, seated below the deltoid, M. Roux made two parallel incisions in the direction of the fibres of the muscle, isolated the tumour below the bridge formed between the two incisions, and detached it at its base with a saw, without any transverse division of the muscle. In some cases where the excision of the exostosis is dangerous or impracticable, and the tumour is neither large nor attached by a broad base, it has been recommended to lay it bare and strip off its periosteum, in order to deprive the external part of its nourishment from the periosteal vessels, and cause the surface and the subjacent parts to slough away. The result of such a method would necessarily be tedious and more or less uncertain; and it is hardly likely that any instances can arise in which its application would be advisable.

OYSTS IN THE BONES.

This peculiar form of degeneration has been frequently ob-

served in the upper and lower maxilla. It has also been occasionally met with in the extremities of the long bones and the bodies of the vertebrae. The cavity of the cyst is most commonly filled with a mass of fibro-cellular matter, but sometimes its place is supplied by serum, pus, hydatid vesicles, gelatinous or colloidal masses, etc. etc. The fibro-cellular cysts of Dupuytren may be considered the same affection as that ranged by Sir Astley Cooper under the head of *cartilaginous medullary exostosis*.

The cysts in the bones vary in size from that of a musket bullet to that of the fist. The peculiar nature of the substance they contain it is exceedingly difficult to discover, except by an exploratory puncture, or during the progress of an operation for their removal. This, however, is not a matter of great importance, as the indications of treatment are nearly the same in all. That which is more easy, however, and more important, is to distinguish the cystic from the cancerous degeneration of the bones called osteo-sarcoma, in which the operation for the removal of the disease is nearly as unpromising as it is successful in the case of cysts. Osteo-sarcoma is characterized shortly after its commencement by a varicose tumour, and by a simultaneous affection of the surrounding soft and hard parts disposed to take on the character of fungoid degeneration, and by irregularities over the surface of the swelling. Osteo-sarcomatous tumours grow with great rapidity, and are traversed in their interior by

fragments of bones, which are never observed in the cysts. These latter are slowly developed, smooth on the surface, and never involve the surrounding parts in disease, unless the contained substance has in the end degenerated into cancer. Their walls, which appear to be formed by a separation of the compact portions of the bone, grow thin in consequence of their expansion, and yield to pressure of the finger like a piece of parchment, followed in many instances by a *crackling* or crepitating sound, which, according to Dupuytren, is pathognomonic of this affection.*

Four principal methods have been employed in the treatment of these bony tumours.

1. *By compression*.—This has been attempted, but the trial has not been attended with any permanent advantage.

2. *By incision*.—The mere laying open of the cysts, and evacuating their contents, even when these are of a fluid nature so as to admit of the process, has not succeeded in effecting a cure. It is necessary to destroy or change the nature of the membrane lining the cyst, without which the orifice will close, and the contents accumulate anew.

3. *By the seton*.—A seton passed through the centre of the cavity, offers in the serous cyst a somewhat better prospect of a cure, by producing suppuration of its walls, and the elimination

* Leçons Orales de Clinique Chirurgicale, t. iii.

PLATE XXIII.—OPERATIONS ON THE BONES FOR NECROSIS.

(Fig. 1.) EXTRACTION OF A SEQUESTRUM FROM THE OS HUMERI.

An incision is made down to the bone, on the outer part of the arm, between the brachialis anticus and triceps muscles. The muscles have been dissected off from the bone, and the fore arm somewhat flexed so as to admit a wide separation of the lips of the wound. Two perforations have been made with the trephine through the new shell of bone, or *involucrum*, so as to expose the *sequestrum* or dead piece of bone inclosed by the involucrum. In the plate, the surgeon with his left hand supports the limb, and draws away the inner lip of the wound, (the external supposed to be drawn outwards by an assistant,) while, with a Hey's saw in his right, he begins one of the lines of section of the involucrum, between the two *places* of perforation, in order to remove the intervening bridge, and get hold of the sequestrum with the forceps.

(Fig. 2. A C). EXTRACTION OF A SEQUESTRUM FROM THE UPPER AND MIDDLE PART OF THE TIBIA.

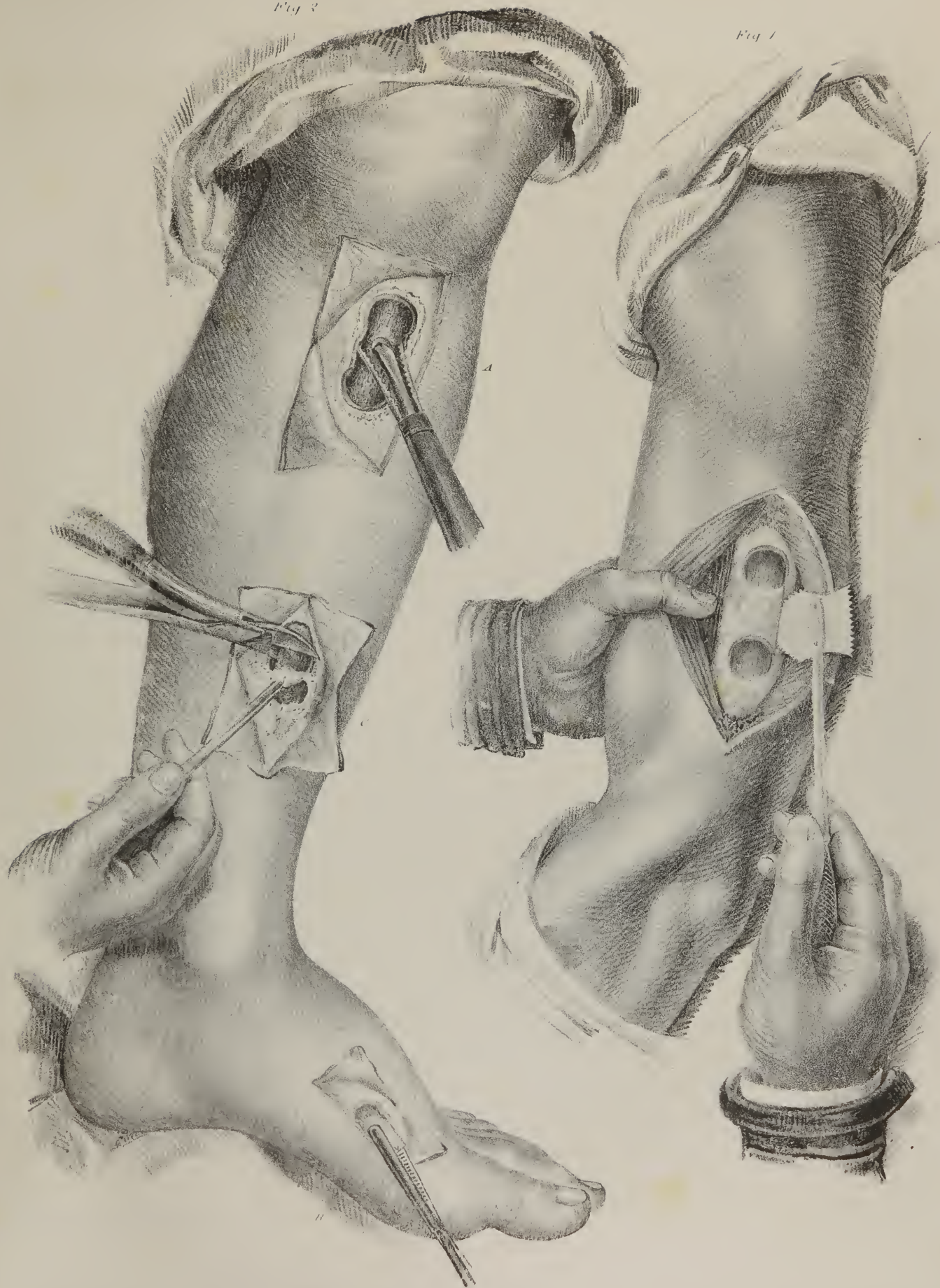
- (A). A wound in the shape of a T has been made, and the two angular flaps dissected up and turned back from the inner face of the bone. Two perforations have been made through the involucrum, and the intervening bridge removed as described in fig. 1. The perforator of Dupuytren, which consists of a pair of serrated forceps and a drill enclosed in a canula, is seen applied for the purpose of dividing the sequestrum, so as to facilitate its removal with the forceps.
- (C). A crucial incision has here been made, and the four triangular flaps dissected from the bone and reverted. The drawing represents the parts as seen in one of the author's operations. The involucrum, which was soft, was opened with the gouge and mallet as seen in the plate. After a free passage was made through this part, the sequestrum was divided with a strong pair of cutting forceps, and the fragments subsequently removed with the pliers. The two instruments are shown at the same time merely for the purposes of illustration.

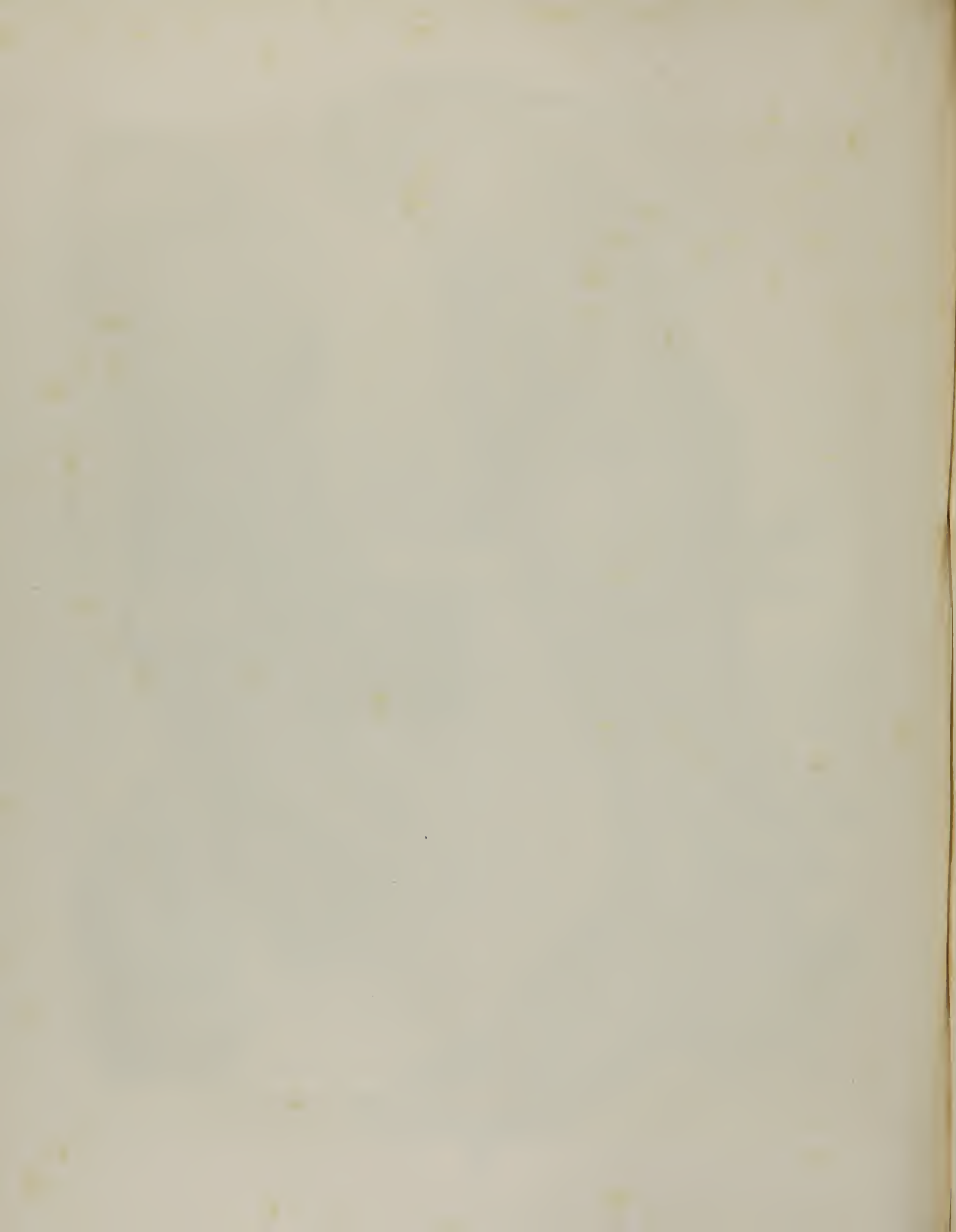
(B). EXTRACTION OF A SEQUESTRUM FROM THE METATARSAL BONE OF THE GREAT TOE.

A T shaped incision has been made, and the involucrum opened as in the operation last described. The dead bone is seen in the act of being withdrawn with the forceps.

Fig 2

Fig 1





of the contained substance. This has succeeded happily in my hands in one case of a cyst developed in the lower jaw. It is, however, much less to be relied on than the following process, which has received the sanction of more general use.

4. *Excision*.—It is usual to commence with an exploratory puncture to ascertain the nature of the contents. An incision through the soft parts is then to be made over the surface of the tumour. In many cystic tumours of the jaw bones, the incision for the purpose of avoiding a scar is made on the side of the mouth. A strong bistoury is then to be pushed through the walls of the cyst, at its most depending portion, laying it open throughout its whole extent. With the scissors or cutting forceps, two oblique sections are to be made so as to take away a triangular portion of the wall. The contents of the tumour having been turned out, its cavity is to be stuffed with charpie or lint to excite suppuration. Stimulating injections into the interior, or the passing of a seton through it, conjoined with external compression, become useful measures in the course of the after treatment, and sometimes are absolutely necessary to effect the complete obliteration of the cavity.

Remarks.—Scrofulous enlargements of the phalanges of the fingers and toes, and of the metacarpal and metatarsal bones, with such softening of the bones as to be readily perforated with a needle, are frequently, and especially in children, met with, that might without attention be mistaken for this affection. In several instances, I have been called to cases of this description in which propositions had been made to lay open or amputate the parts. Such bony enlargements are usually got rid of without much difficulty, by the ordinary treatment for the cure of scrofula.

CARIES AND NECROSIS.

These affections are essentially different in their nature—*caries* consisting of the ulceration, and *necrosis* of the mortification of the bony structure. Yet in their general outlines there is such similarity, that advantage will be derived in briefly studying them in conjunction, inasmuch as they are often found combined in the affection of the same bone, or the one is found preceding the other, exactly in the same manner as ulceration and mortification of the soft parts. Both caries and necrosis are commonly preceded by the symptoms of deep-seated inflammation, which is after a time manifested on the surface, and may be produced by external causes, such as a blow, contusion or wound, but more generally is the effect of some constitutional affection, as scrofula, syphilis, and scurvy; in short, everything which gives rise to ulceration and mortification in the soft parts, may similarly affect the bones, the symptoms only being modified by the difference of texture in the latter. In caries, there is undoubtedly inflammation of the osseous tissue. In necrosis, on the other hand, the periosteum is frequently alone involved; which, detaching itself from the bone, the latter mortifies, in consequence of its nourishment being interrupted. Formerly, it was thought that collections of pus produced both caries and necrosis, by infecting the bone. This is not commonly the case; and in general, when either caries or necrosis is discovered on the opening of an abscess, we may fairly presume that they have been the cause and not the consequence of the purulent deposit. The osseous tissue

is not everywhere equally disposed to either of these affections. The more compact bones, and especially the bodies of the long bones, on account of their low vitality, are more liable to mortify than ulcerate, though it is not true, as has been asserted, that the spongy textures, such as the apophyses and epiphyses, are never affected by necrosis. The spongy bones, and the spongy portion of the long bones, in consequence of the looseness of their texture, and their vascularity, are generally the seat of caries. This latter affection, moreover, seldom penetrates to a great depth in the bone; necrosis, on the contrary, except it be the result of an extraneous injury, affects as often the inner table as it does the outer surface of the bone, and has therefore been properly divided into *central* and *peripheral necrosis*, according as the disease depends primarily on the affection of either the internal or external periosteum. But, as previously mentioned, the same bone may be affected by both caries and necrosis,—a complication which is most frequently found attendant on the venereal affection of the osseous tissue.

Long before either of the diseases are made manifest externally, they are preceded by deep-seated pain; that which is antecedent to caries, is usually less violent, raking, burning or shooting, and is attended with less feeling of heaviness in the limb, than that precursory to necrosis. As soon as the ulceration or caries of the bone is established, and an accumulation of sanious ichor takes place, the parts around will participate in the inflammation, become swollen and indurated; and the accumulated sanious fluid gradually makes its way to the surface. This is attended with only partial relief, and sometimes without diminution of the symptoms. But if the bone has mortified, or become necrosed, the pain may altogether subside for some length of time, no symptom being left behind, except a great weakness and heaviness of the limb concerned. But as soon as an effort is made by nature to discharge the dead portion from the system, tumefaction and inflammation follow, confined usually to the region of the necrosed part, but generally of a more chronic character than that accompanying caries. The abscess thus slowly formed round the dead bone, opens early if the bone be superficially seated, but sometimes not for months if it be deep; or, if the constitution of the patient be weak, it may not be possible for nature without assistance to evacuate it at all. When the abscess opens, pus of a more healthy character is discharged than in cases of caries. The appearance of the external fistulous orifices, as well as the quantity of the discharge varies in the two forms of disease so as to constitute the characteristic symptoms, by which they may be distinguished from each other. In caries, the orifices are few in number, (and very frequently there is no more than one,) funnel-shaped, narrow, and surrounded by prominent callous margins. Exuberant and unhealthy granulations, which bleed from the slightest touch, spring from the canals into which these orifices lead. On passing down the probe through these canals, which are very sinuous, the bone is found, from the hypertrophy of its vascular tissue, soft, spongy, porous, and gives to the end of the probe a sensation as though it was passing through a bag of sand or wetted sugar. The secretion is usually copious, compared with the extent of the ulceration, and blackens the silver of the probe. In necrosis, the apertures are generally numerous, irregularly shaped, and lead either directly to the seat of the disease,

or through the cavity of the abscess if the parts above the bone have not yet sunk in, as is generally the case after the external opening is made, when the bone is superficial. When the bone is more remote from the surface, sinuous cavities form, which communicate with the outer apertures. The granulations which are sometimes found studding these orifices, as well as the matter discharged, present a more healthy appearance than those observed in fistulæ formed from carious bones. If a probe be introduced through one of these orifices, the bone will be found bare, and gives a ringing sound when struck.

In their further progress, the two diseases vary greatly. Caries goes on uninterruptedly in the destruction of the osseous tissue, unless arrested by treatment. In necrosis, on the other hand, the disease, properly speaking, is extinguished with the mortification of the bone; and the troublesome symptoms which subsequently arise, proceed from the efforts of nature to cast off the dead portion. This result has, therefore, always been considered a favourable circumstance to the disease of the bone, and has been made the basis of a treatment for the cure of caries, by changing the ulceration into necrosis.

SPONTANEOUS AND ARTIFICIAL CURE OF NECROSIS.

To remove the dead portion of bone, a twofold action is set up on the part of the system; first, to reconstruct new bony matter for the use of the limb, and secondly, to detach or expel the old. The new bone is formed slowly from the periosteum, and in consequence the insertions of the muscles remain unchanged. In the interior of the new bone, which is called the *involucrum*, is lodged the dead portion or shaft, which after a time becomes completely isolated through the action of the absorbents, and takes the name of *sequestrum*. If the whole shaft be struck with necrosis, it is detached at its ends from the spongy extremities of the bone; and in cases of long standing, is frequently, as I have had occasion to witness, separated from the involucrum as well as the heads, by an exceedingly vascular pyogenic membrane, which lines the interior of the involucrum, and stretches across between the heads and the dead portion. The sequestrum, acting as a foreign body, provokes a constant suppurating discharge from the membrane, and becomes itself diminished in bulk, though it is never wholly destroyed. The matter finds its way from the cavity through the orifices, improperly named *cloaca*, which it keeps open in the involucrum, and from these escapes by various sinuous channels leading to openings in the skin, and which are placed most usually in the principal intermuscular spaces. In a long series of years, it is possible that the sequestrum, either in pieces or in mass, may be detached through these channels, especially when, as sometimes happens, the limb bends so as to place one of the cloacæ opposite one of the ends of the dead piece, which then advances itself to the surface, and may be at once removed—the cavity of the new bone from which it has been taken afterwards closing up. This is what is called the spontaneous cure for necrosis. It is, however, a process upon the occurrence of which the surgeon cannot rely, and which is never accomplished but at an expense of time and strength, which the patient in most instances can but ill bear. Cases have, however, come under my observation, where the necrosed piece was of limited size, the source

of little or no irritation, and the discharge so limited as to constitute little more than the drain from an ordinary issue, when, from the peculiarity of constitution, it has been deemed wisest to leave it undisturbed. As a general rule, however, the work of nature should be abridged by the interposition of the surgeon. This is to be done by methodically opening the involucrum and removing the dead portion by a process of art.

EXTRACTION OF THE SEQUESTRUM.

This is not to be attempted until the dead portion is completely isolated from the living, as is made obvious by the application of probes through the fistulous openings upon the bone. As soon as the sequestrum is ascertained to be loose, the operation ought to be undertaken, lest by waiting, the system should become exhausted, and the new-formed bone acquire, as it does in the end, so excessive a degree of hardness as to increase seriously the difficulty of the operation. Nor should it be attempted earlier, for fear that the new bone may not have become sufficiently firm to prevent the limb from bending under muscular action, after the removal of the sequestrum. In several instances after the removal of the shaft of the tibia in persons below the age of puberty, I have observed that the new-formed bone grew, so as to give to the affected limb a length greater than that of the other side.

Operation.—If the sequestrum is small and visible through a large fistulous orifice, it can at times be seized with the forceps and withdrawn. Generally, however, it will be found necessary to enlarge the cloaca, by opening the involucrum, and break or divide the sequestrum, to facilitate its extraction. For this purpose the patient is to be placed horizontal, and properly secured. A semilunar, γ , or crucial incision is then to be made, so as to lay naked a superficial portion of the bone by turning back the flaps. The surgeon is then to enlarge one of the cloacæ by the gouge and mallet, the cutting forceps, the trephine, or even a Hey's saw, as is found most convenient, so as to get at the sequestrum. If no cloaca presents itself, the use of the trephine becomes nearly indispensable, and may be employed to make two or more perforations, dividing the bridge between with the saw, as seen in Plate XXIII. If the bone is soft, the hand gouge or a strong scalpel sometimes may answer to open the passage to the dead bone. Having reached the sequestrum, it is to be seized at one end with a pair of forceps, and inclined from side to side to detach it from its bed. If it does not yield to the traction, it must be broken or divided near its middle with the cutting forceps, a small trephine, or the perforator of Dupuytren, and the fragments removed separately. Considerable caution should be used in this step, neither to break nor bend the new bony shell, nor tear the membrane lining its interior.

The *after treatment* must be such as is suited to ordinary suppurating wounds. The cure will necessarily be protracted, and even after the wound is closed, the patient should begin cautiously to use the limb, for fear it may become curved or break.

Remarks.—Cases occasionally present themselves especially in the thigh and arm bone where an abscess of the medullary cavity, protracted for years, gives rise to the thickening of the limb, the enlargement of the superficial veins and the formation of cloacæ leading into the cavity, and in fact all the signs of necrosis except

that peculiar one the ringing and mobility of the fragment on sounding it with a probe. In such instances the proposal of Prof. N. R. Smith, of Baltimore, to tap the abscess with the trephine and give free vent to the matter, may be followed with advantage.—The author treated with complete success by this process a case of internal abscess of the femur of seven years' standing, in a man whose constitution had been broken down by the protracted suppurating discharges. The operation was performed before the class at the Philadelphia Hospital in the winter of 1844-5. There were three narrow sinuses upon the outer and two upon the inner side of the lower third of the shaft of the bone leading by circuitous routes into its cavity. These would occasionally close up more or less completely, and the closure be followed by a new abscess round the bone. The operation consisted in making, down to the bone through the outer sinuses, a vertical incision turned at the lower end, by a semicircular sweep of the knife, toward the front of the thigh, and through the vastus externus muscle; the flap was then raised from the new bone, two perforations made with the trephine, and the bridge between them removed with the cutting forceps. From the free opening thus made, the pus from the cavity of the bone had free exit. Abscess ceased to form around the bone, the old cloacæ closed up, and by the use of injections of sulphate of zinc, with the application of dry lint and poultices, the cavity of the bone was gradually obliterated. The treatment lasted for two months, during which time a few spiculæ of necrosed bone were discharged through the wound.

OPERATION FOR CARIES.

This comprises two methods:—Cauterization and resection.

Cauterization—Preparatory measures.—The affected portion of bone must be thoroughly uncovered by reflexion of the flaps, after a crucial, a T, V, or elliptical incision. All the fungous growths are then to be first removed with the bistoury and scissors from the surface of the bone, and the diseased fungous structure of the bone itself, taken away with the gouge and mallet and the raspary, till we reach a surface which is natural in regard to colour and organization. If a portion of the soft parts has undergone degeneration, it is directed to remove it, taking care, however, to preserve enough to form a covering for the denuded bone. The author has, however, found it better to be sparing in the removal of any of the soft parts, as the lardaceous state of the tissues, which is the common character of the degeneration, may commonly be corrected by the after treatment. Waiting till the bleeding ceases, and carefully absterging the bone, cauterization is to be next employed. This may be done with caustic substances, but better still with the heated iron, carefully protecting the surrounding soft parts from injury.

Caustic substances.—The soluble nitrate of mercury, as well as various other liquid caustics, was formerly employed by dipping a piece of lint or charpie in the solution, and applying it for several times, at intervals of many days, upon the surface of the bone, till the exfoliation of a necrosed lamina took place; a result which seldom occurred under fifteen or twenty days. By this method it is difficult to prevent the liquid from acting injuriously on the soft parts. The newer caustic preparations, as the zinc or Vienna paste, are more active and far less likely to run, and should

always be used in preference to the liquid articles. They may, as observed at page 21, be employed in some cases in preference to the actual cautery, when, from the nature of the parts, the latter cannot be used without danger. When the caustic is removed, the wound should be carefully cleansed, and dressed flat with a roll of charpie or lint, so as to keep the flaps everted. The common tediousness of the cure by the use of caustics, and the difficulty of their application, have induced many surgeons to give a decided preference to the actual cautery, as the most prompt and certain method of arresting the progress of caries.

Actual cautery.—The mode of employing the heated iron has already been described at page 24. The disk-shaped cautery will be found most appropriate where a large surface is to be acted on; the conical or cylindrical where there are mere excavations or fistulous channels in the bone. After reflecting the flaps of skin from the carious surface to protect them from the heat, a sort of canula should be formed with a piece of moistened cord, which is easily adjusted to the particular configuration of the diseased part. Having arranged this, and carefully removed all moisture from the face of the bone, the cautery heated to a white heat is to be carried rapidly and slightly over it. The heat causes at first the blood, sanies, or pus, which fills the spongy tissue of the diseased part, to boil up as it were from the surface; this fluid should be carefully removed as it rises, with a sponge or roll of charpie held in the left hand of the surgeon, or applied by an assistant. Two three, or if necessary, four irons, according to the extent of the disease, will be required; carrying one of the irons into such fistulous passages, as come into view, in order to destroy as effectually as possible every remnant of the caries. In order to diminish the pain of the operation, the iron should be changed as soon as it loses colour, which occurs speedily when there is much fluid in the carious structure. A sharp pain is felt in the bone as soon as the carious portion is destroyed, which serves as a proof that the cauterization has been carried to the requisite extent. The pain soon ceases on the removal of the iron. Simple dressing with dry lint or charpie is all that is required for a few days following the operation. At the end of a week suppuration is established, and the dark eschar left by the iron begins to be detached by the development of granulations from the healthy surface of the bone. If, on the contrary, partial exfoliation only takes place, attended, at the end of the second week, with sanious suppuration and fungous growth, the cautery must be re-applied. If any fungous granulations spring from the edges of the flaps, they may be repressed with the lunar caustic or the soluble nitrate of mercury.

Resection.—The object of this operation is to completely remove the carious portions of the bone with a cutting instrument. For the removal of small and superficial portions, the parts are to be exposed by the elevation of flaps, and the altered bone removed with the gouge, the saw, or other fitting instrument. No particular rules need be given in cases of this description. The mode of resecting larger portions of bone will be particularly detailed, in a section devoted to that subject.

TREPANNING OR TREPHINING OF THE BONES OF THE CRANIUM. (PL. XXIV.)

The object of this operation is the elevation of a depressed

bone, the removal of a fractured or diseased portion, the extraction of foreign bodies, or the evacuation of blood, serum, or pus, which has been effused within the cavity of the cranium. The use of the trephine dates from the time of Hippocrates, who has given in respect to it some very judicious instructions; but in no other operation have the opinions of the older and more modern surgeons differed so much in respect to its value. This is in a great measure owing to the delicacy of the structure and the important offices of the brain, the only circumstances that give to injury of the bones of the cranium any peculiar importance, the brain being liable to become involved in injuries of these bones in such a variety of ways, either from the direct or secondary effects of the injury itself, or as the immediate or remote consequences of the operation for its relief. The proper indications for the use of the trephine, in depression, fracture, compression, etc., cannot here be satisfactorily shown, without going more extensively into a consideration of the effects of injuries of the brain than would

accord with the limits of this work. Referring the student, therefore, to the treatises on this subject, I shall, after a few brief remarks, proceed to consider the operation.

Marchetti, Sala, La Motte, and several modern surgeons, assert that they have employed the trephine with success in cases of epilepsy; and Panarotti and Fabricius Hildanus, for chronic cephalalgia and hypochondriasis. Were such affections obviously dependent on the presence of a foreign body, a tumour, or an exostosis of the inner surface of the cranium, there would be some indication for the operation. But in cases of this description, even where the affection can be directly traced to local injury of the cranium, it is often exceedingly difficult to make out the diagnosis with sufficient certainty to warrant the resort to so serious a proceeding. It is, therefore, only in respect to injuries of the brain, that the operation will be here considered.

As late as the eighteenth century trephining was, as a general precept, practised without distinction in almost all sorts of wounds

PLATE XXIV.—TREPPANNING OR TREPHINING OF THE CRANIUM.

Fig. 1.—The patient is represented in a state of coma, in a horizontal position, with his head elevated and placed with the injured part uppermost. The hair has been removed from the place of operation, and the four flaps formed by a crucial incision, reverted, so as to expose the bone in the fronto-parietal region. Three instruments, for the purpose merely of exhibiting their use, are shown applied upon the wound; but it must be recollected that one only is to be employed at a time, and that so extensive a removal of the bone as here shown is rarely justifiable in the living subject.

- a.* The left hand of the surgeon, holding between the thumb and fore finger the top part (*b*) of the French trepan, upon which the surgeon rests his chin in order to steady the instrument.
- c.* Thumb and fingers of the right hand grasping the rounded part of the brace, with which the surgeon gives the circular movement. Four circular pieces or disks have already been removed in this case, which is supposed to be one of extensive hemorrhage over the dura mater, and the trepan is shown as on the point of being removed after a fifth application, in order to give free issue to the fluid, as directed by many surgeons.
- d.* Surface of the dura mater, exposed by the removal of the four first disks.
- e.* The cutting pliers, applied to cut out the angular projections left by the removal of the disks.
- f.* The right hand of the surgeon, removing with the lenticular knife the rough edges of the under surface of the divided bone.

Fig. 2.—Same region of the head as shown in *fig. 1*, with the flaps similarly reverted after a crucial incision. The injury has been inflicted with the corner of a brick bat, which comminuted and depressed a portion of the bone. A small central fragment has been detached with the point of the perforator (*fig. 9*), so as to make room for the end of the elevator, with which all the loose fragments are to be removed and the depressed margins elevated. Cases of this description frequently occur, in which the use of the trephine is not needed.

Fig. 3.—This represents a fracture of the right parietal bone, with an extensive longitudinal wound of the scalp, which has been enlarged by a vertical cut at either end, so as to allow the operator to expose the bone (*c*), by reverting two flaps (*a* and *b*), one upwards and the other downwards. The bone is extensively fissured, and a central fragment that was depressed has been removed by the application of a trephine, which has left the rounded edge at the lower part of the opening through the bone; the pyramid or centre pin of the trephine having been applied near the lower margin of the longitudinal fissure seen in the bone. The dura mater (*d*), thus exposed by the removal of the fragments, and found covering a mass of blood or pus effused below it, is to be opened with a bistoury from below upwards as directed in the text.

Fig. 4.—This sketch is intended to illustrate the manner of holding the English or ordinary trephine, as well as the rules for determining in many cases the proper point for its application, when it is deemed best either to raise or remove the depressed fragment. The os frontis has been fissured, and a fragment of considerable size depressed. The bone has been exposed by a crucial incision and the reflection of four large flaps. The trephine was first applied at *b*, and the disk removed; an attempt was then made without success to raise the depressed portion. Another disk was then removed at *a*, and a second attempt made with like want of success, on account of a shelving piece from the inner table being attached to the fragment, as is most commonly the case at the margin

Fig 1

Fig 8

Fig 7

Fig 6

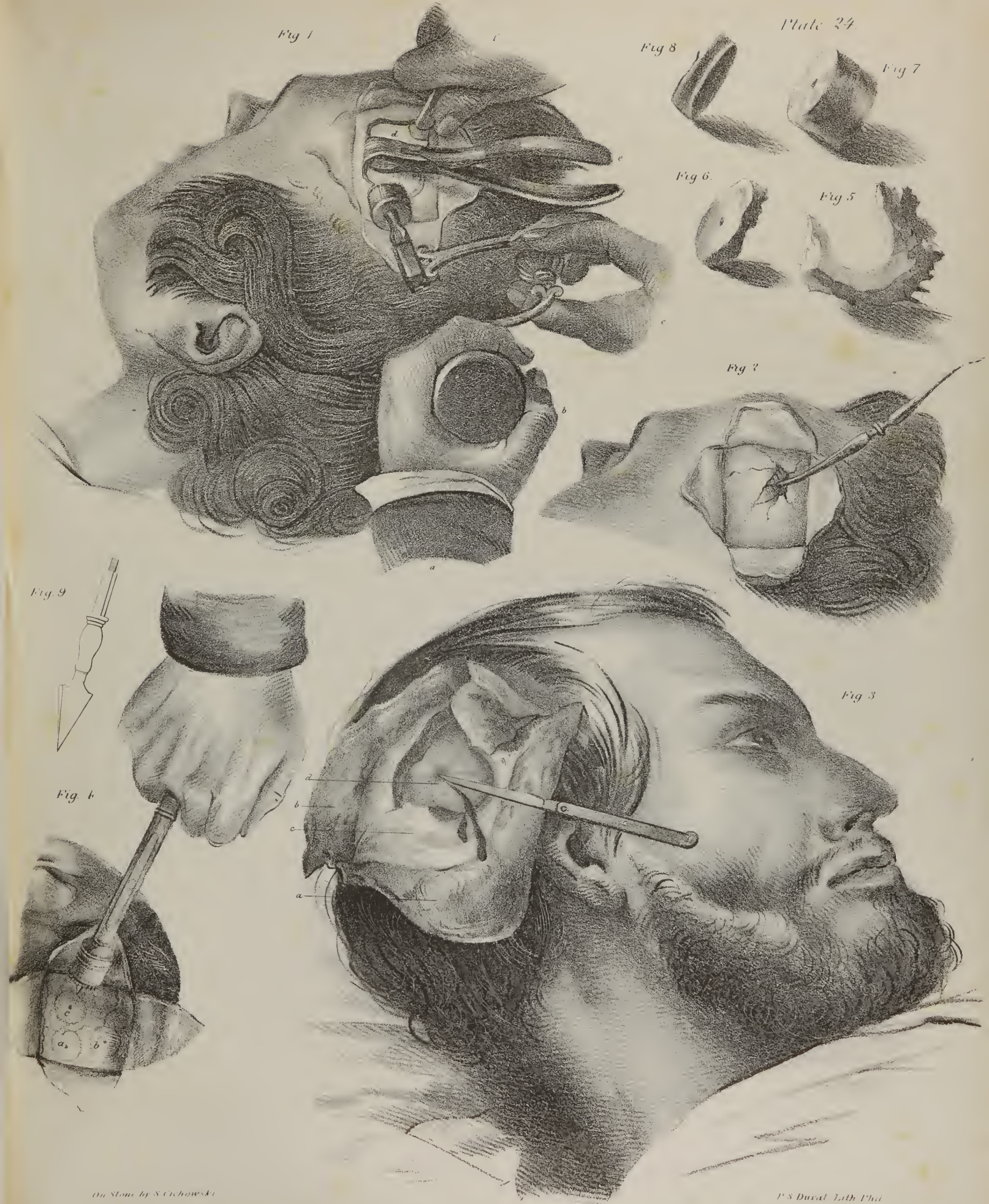
Fig 5

Fig 2

Fig 3

Fig 9

Fig 4



and injuries of the head, not only as a means of cure for the symptoms of irritation or compression to which they might give rise, but as a *means of protection before they were developed*.

The gross abuse of the application of the trephine, to which such indications would lead, has been vigorously opposed, especially by Desault, Abernethy, Langenbeck, Physick, Gama, Cooper, and others, who restricted its use to cases in which the secondary symptoms of irritation and compression were strongly manifested, waiting always as regards the operation until these should appear. This doctrine was founded chiefly upon the serious nature of the operation, and upon the well-known fact that effused blood may be completely removed by absorption under the influence of appropriate treatment, and that even the depression of a piece of bone will frequently be borne without injurious consequences. The reaction thus produced mainly by the influence of Desault and his school,* established on the other hand an excessive repugnance to the operation, and trephining came to be considered as a desperate resource, which, if used at all, was apt to be applied too late. But the careful opening of the walls of the cranium, where no inflammatory symptoms prevail, is not of itself an operation of very serious danger; and the suc-

* Saviard, more than one hundred years ago, found that most of the patients trephined at the Hotel Dieu, (when many surgeons, not yet having learned the value of saving the integuments to cover the wound, cut away the scalp from over the place of operation,) died soon afterward, in that unhealthy institution, of what was called the fever of the hospital. He objected to the use of the trephine. Desault followed more warmly on the same side, rejecting it almost in toto. Abernethy took up the subject on a different ground, and, without abandoning the operation, endeavoured to distinguish the cases suited for it; and laid down the rule, that the surgeon was not to trephine merely because there was fracture, depression, etc., but only for the consequences that these had produced. This has since been the ruling doctrine among British and American surgeons. Sir A. Cooper, Sir B. Brodie, and others, have receded slightly from the ground taken by Abernethy, and admit the immediate use of the trephine in cases where there are fracture and depression complicated with external wound. So little a matter, however, is the existence or the non-existence of an external wound in so serious an affection, that the admission would seem to imply that a more frequent use of the trephine would be found advantageous; and Velpeau, in a more decided tone, advocates its employment.

The subject, however, requires to be studied anew, with careful reference to the statistics of the operation, before full and precise indications can be laid down for the various cases that occur; for as yet some consider it doubtful whether indiscriminate trephining immediately after fracture and depression, would not be attended with nearly as good results as the modern practice of Abernethy and Desault.

cess which the older surgeons met with after its employment, compared with the almost constant fatality which has followed its use in later times, goes to show that the cause of death in the latter instances is to be found in the restriction of the operation to the worst class of cases, and partly perhaps in the fact that the affection of the brain and membranes consequent to the injury had been allowed to develop itself previous to resorting to the operation. Though in every respect opposed to the prodigal use made of the trephine by the older surgeons for the purpose of *preventing inflammation*, I believe, from what I have myself witnessed, that it would be well, (notwithstanding the exceptional cases reported, of musket bullets and splinters of bone becoming encysted within the cranium without producing serious results,) if the attention of the profession in this country was brought to a less unfavourable view of the operation *early after the occurrence* of the injury, when, according to the principles established by Pott, it would enable us to get rid of an obvious cause of irritation, whether that be a foreign body, a depressed bone, a splinter from the internal table, or a mass of effused blood. I cannot but recall cases to mind, and every surgeon of experience in all probability can do the same, where the early use of the trephine might have saved life—such, for instance, as that of a depressed bone with a splinter from the external table sticking into the substance of the brain, and exciting abscess; the crista galli of the ethmoid driven by a blow on the forehead into the anterior lobe of the brain; various fissures of the skull from external violence, leading to effusion, compression, and meningeal inflammation; and ruptures of the middle artery of the dura mater, by a blow even with the fist, and without fracture of the bones. The admirable cures effected by Larrey in many cases of injury of the head, are well known; and the counsel left by that experienced surgeon is, if we are called in within the first twenty-four hours after the reception of the injury, to proceed at once to the removal of such foreign bodies, splinters, or extravasated fluids, as the case may render necessary; but if not summoned until after the inflammatory symptoms are set in, to defer an operation till they have been abated by treatment. If, however, the removal of an irregular-shaped fragment sunken in the brain cannot be made without inflicting much additional irritation, it will be better for the surgeon to desist and trust the case to the efforts of nature, after having obtained a free outlet for the fluids which may form.

where the depression is greatest. A third application of the trephine was then made at *c*, and the fragment taken away without difficulty, its removal being necessary in consequence of the complete insulation of the piece and its pressing by its rough edge on the dura mater. This is the only place at which the perforation should have been made. The two former perforations were not only unnecessary, but contributed to enlarge the gap in the bone, and increased the risk of hernia cerebri, which in a case analogous to this, described by Sir C. Bell, actually occurred and destroyed the patient.

Fig. 5.—A portion of bone, which exfoliated after the use of the trephine in consequence of the dura mater having been detached from its under surface by injury.

Fig. 6 and 7.—Two portions of different skulls, removed from the same site in each, showing the variable degree of thickness of the bone in different individuals, and the necessity of always proceeding cautiously in the use of the trephine, lest the dura mater should be injured.

Fig. 8.—A circular piece of bone, showing the two tables and the intervening diploic structure. The last four figures are taken without alteration from Bell.

Fig. 9.—The perforator. This is frequently a very useful instrument in enlarging a fissure where small fragments are depressed. It may be attached to the handle of a trephine.

Sir P. Crampton* was obliged to give over an attempt of this sort, where the fragment of bone was lodged in the substance of the brain in consequence of the convulsive movements and moanings excited; the fragment in this case was subsequently discharged by suppuration.

Fractures of the bone, with or without depression, it is frequently by no means easy to discover, when there has been no opening in the scalp. In such cases, it is well to follow the advice of Cooper, Brodie and others, and not, unless the symptoms are of such a nature as fairly to indicate it, proceed from mere surgical curiosity to lay open the scalp, as the incision would necessarily be attended with an increased risk of erysipelatous inflammation. A proper distinction should be made as to the effects of depression, in reference to the age of the patient; for in children the skull is more yielding, more readily depressed without fracture, than in the adult, and has a greater natural tendency to restore itself to its previous state.

The following are the indications for the use of the trephine in recent injuries, as given by M. Bourguery, one of the latest writers on the subject,—though his first division, as it would appear to most surgeons, should be accepted with much qualification.

1. In all fractures of the cranium, with or without depression. 2. Whenever the tissue of the bone is much broken up. 3. In every case where the dura mater has been involved in a penetrating or punctured wound. 4. In gunshot wounds, complicated with the presence of foreign bodies. 5. When coma and compression come on in a few hours after the injury, especially after a blow over the temple. 6. When epilepsy follows in a case where there is a prominently depressed portion of bone, attributable, without chance of mistake, to the injury which the bone has suffered.† In many of the indications included in this category, the application of the trephine may not be needed, if the offending portions of bone are so loose as to be readily removed with the elevator, or the male branch of a pair of scissors; or if the wound of the bone is sufficiently large to permit the extraction of any foreign body lodged in it, or to give issue to the products of hemorrhage and suppuration.

Instruments required for the operation.—1. The common English hand trephine, seen at fig. 4, Plate XXIII; or the instrument of Hildanus, known by the name of the French trepan, fig. 1, which is worked like a joiner's brace. 2. A tirefond or bone screw, like the tooth screw of the dentist. 3. A strong lenticular knife, with different sorts of elevators. 4. Dressing and cutting forceps. 5. A small brush to clean out from time to time the circular groove made by the trephine, and a piece of quill or ivory to measure occasionally its depth. 6. A straight Hey's saw and some bistouries. To these might be added, at the will of the operator, the osteotome of Heine or Martin, which are particularly useful here, as well as in trephining other portions of the bony structures for abscess or necrosis. It will also be found advantageous to have at hand an oblong piece of sole leather or cork with a crevice cut in it, if we expect to use the Hey's saw, or a circular opening for the crown of the trephine, if we are disposed to apply this

instrument on any point where the use of the pyramid would not be considered prudent.

Points of application.—Authors in general direct the operator not to apply the trephine over the frontal sinuses, where the separation of the two tables of the bones renders the operation more difficult; nor at the anterior and inferior angle of the parietal bone, which lodges in a groove or canal formed in its inner table, the middle artery of the dura mater; nor upon the track of the sagittal suture, for fear of wounding the longitudinal sinus; nor upon the middle of the temporal fossa, where several vessels and a large muscle are found; nor over the common junction of the sinuses at the occipital protuberance. These rules are good, and should always be respected, unless a well-founded indication exists for their violation; for the accidents liable to accrue from the operation at these excepted points may be easily guarded against. Hemorrhage from the artery of the dura mater may be arrested by a ligature, as was done by Dorsey; if lodged in a canal, by plugging, as practised by Physick; or by cauterization with a heated stilet, in imitation of Larrey. The slightest pressure with a piece of lint suffices to check hemorrhage from the sinuses. By using the precaution of Sir C. Bell, to open the anterior wall of the frontal sinus with a large trephine, and the inner with a smaller, depressing the handle of the latter so as to act square on the bone, we may cut in the supra-orbital region with nearly as much safety, as regards the dura mater, as any other portion of the cranium. The separate removal of the external table is not, however, in all cases practicable, in consequence of the incomplete development of the sinus in young persons.

The selection of the point for operation will depend upon the location of the injury, and the object we have in view; for sometimes it has been found necessary to apply the trephine upon the side opposite to the external injury, when, from the effect of counter stroke, an effusion of blood or a gradual accumulation of pus or serum has occurred there. In simple fracture, we should apply the instrument with the pyramid resting near one margin of the fissure, so that the section may extend upon both its sides. In fractures with depression, care must be taken that the crown of the trephine does not act upon a loosened bone, for fear of causing irritation or laceration of the parts below. When a foreign body is wedged in the wound of the bone, and the fracture is but limited, the crown of the trephine should embrace the whole solution of continuity. If a musket or rifle bullet penetrate the cavity of the skull, the smallness of the aperture which it leaves will lead the inexperienced to doubt the fact of its passage. The osseous fibres, yielding to the impulsive force of the ball, diverge many of them without breaking, and rebounding after it has passed, nearly close the aperture. In young subjects, where the bones are most elastic, this is particularly the case. In old individuals, the fibres are more disposed to break, and the ball takes out a portion of the bone at least equal to one-half its diameter.

A ball or similar foreign body, when its direction is such as to keep it between the bone and dura mater, may lodge at a spot a little remote from its place of penetration, without the extraction of it being thereby rendered impossible, or the case entirely hopeless.* In such instances, it has been advised, in order to ascertain the location of the foreign body, (when its presence gives rise to

* Dublin Journal of Med. Sciences, vol. ii. p. 42.

† Vide a valuable paper on injuries of the head, by Prof. Dudley, in the 1st No. of Transylvan. Journ. of Med.; and (among others) a case by Dr. D. L. Rogers, New York Med. and Phys. Journ., vol. v.

* Vide Campagne de Constantine, 1837, by Sedillot.

symptoms of pain or compression, so as to render surgical interference justifiable,) to introduce a caoutchouc probe along its track, the contact of which with the foreign body, will be made known by the feeling of resistance and roughness communicated. Withdrawing then the probe, and measuring the distance in the same direction on the outside, we find the place for the application of the trephine. In cases of extravasated fluids, we operate immediately over the supposed seat of effusion, and sometimes more than one perforation at the distance of an inch or more apart will be required. When the effusion exists over each of the hemispheres, it has in some cases been deemed proper to make an opening on the two sides of the skull, but the chance of relief under such circumstances is nearly hopeless. In caries and necrosis, it is usually deemed most prudent to let the diseased portions separate of themselves, until they can be seized with the forceps and extracted. But if there should be such an accumulation of pus (which usually, however, flows without difficulty, by some external opening), as to give rise to symptoms of compression, a few applications of a small trephine may be made, and the interspaces divided with a Hey's saw or the ordinary cutting forceps.

Operation. (Pl. XXIV. fig. 1, 2, 3).—The point of the cranium upon which we are about to operate having been shaved, and the head supported on an inclined plane, and well secured by assistants, we proceed to the 1st step of the operation, which consists in—

1. *The denudation of the bone.*—No fixed rules can well be given for the division of the soft parts for the purpose of exposing the bone. If there already exists a wound of the scalp, this is to be enlarged in such a way as to admit the application of the trephine, by forming a V, Λ , T, or oval-shaped opening. Where there has been no external wound, the V shaped incision of Physick, with the point downwards, the flap dissected up towards its base and reverted, will uncover the bone with the least division of the vessels in operations over the temporal region. In other portions of the head, I have found the crucial or semilunar incision most appropriate. In making these incisions, the scalp should be divided at once by a single cut down to the bone, care being observed in case of fracture, that the knife does not penetrate below its surface. If the bone be much comminuted, it would be most judicious to make first a slight incision of the scalp, and open it subsequently to the requisite extent on a grooved director. The flaps are then to be dissected up, reverted, wrapped with fine linen, and held out of the way by an assistant. Formerly, it was directed to detach the pericosteum for a space equal in size to the crown of the trephine, with the raspatory, a practice now justly abandoned. If the divided vessels bleed freely, and do not shortly contract under the astringent action of the air and sponging with cold water, they are to be pinched, twisted or tied, as in other parts of the body.

2. *Perforation of the bone.*—This is to be accomplished either with the hand or English trephine, or the trepan instrument of Hildanus, which may be made to revolve either with a brace, or like a drill by means of a bow. The operation is the same with all. The hand trephine is usually preferred in this country and in England, and no possible objection can be urged against its use, except the slowness with which it cuts when the bone is solid.

The pyramid or centre bit is to be protruded beyond the level of the crown of the instrument, and firmly secured with the screw attached upon the side for the purpose. The point is then to be entered into the bone with a semicircular motion of the hand, made by alternate pronation and supination, the arm being held immovably fixed. This motion is to be continued till the teeth of the crown come in contact with the bone, and furrow for themselves a groove in the external table sufficiently deep for the instrument to run in securely. The pyramid, as it is no longer of any use, is now to be retracted, lest it should injure the dura mater by perforating the bone in advance of the teeth of the crown; and the operation is to be continued with the crown alone. This must be kept perpendicularly applied, in order that it may act at an equal depth on all the points of its circumference. The division of the diploe can be recognized by the case with which the trephine cuts, rather than by the bloody detritus removed, usually given as the sign of this stage of the operation by writers. For on the living subject, blood constantly flows in sufficient amount to redden all the particles loosened by the saw. In old subjects and in children, the diploic structure of the bone is deficient, and the crown of the trephine must be withdrawn from time to time in order to clean the teeth with the brush, and furnish an opportunity to sound the depth of the groove, to see if it be equal in all its parts. We then resume the use of the trephine, remitting it after every third or fourth turn to sound the depth afresh, as we suppose we are approaching the under surface of the bone, which is very variable in its thickness in different individuals. If the motion of the crown be impeded in one direction, we make a half turn backward, and continue the operation with slighter pressure. If, on examination, the bone is perforated partially, but the piece still immovable, we are to continue the use of the trephine, inclining it on the adherent side, and avoiding carefully all pressure on the divided point, for fear of injuring the dura mater. When the furrow is cut through at several points, the finger nail or an elevator introduced into the groove, will serve to effect the separation of the remaining portion of the internal table, which takes place with a crackling sound. If, however, the depressed fragment is found to run somewhat shelving under the edge of the trephine, so much motion of it might be caused by the turns of the instrument as to lacerate with its rough edges the dura mater. As soon as this fact is ascertained, the trephine is to be laid aside, and the disk detached by two elevators applied upon opposite sides, to prevent the tilting of the fragment on the membrane.

If the trephine has to be applied so as to cover a small fractured portion, or a ball or other foreign body lodged in the bone, the centre pin or perforator cannot be used to start the crown. A piece of sole leather or cork, with a hole of the proper size cut in its centre, and firmly held by an assistant, will serve to retain the crown until it cuts a groove deep enough for its own support.

Use of the Hey's saw—Cranial saw—Bridge saw of Grafe.—In fractures with depression, where the margin of one bone slides over the other, or in depression without fracture, which I have observed in children when a bone has been driven in at the sutures, or when the mere enlargement of an angular fissure becomes necessary, an opening may be made with this instrument more quickly and more conveniently than with the trephine. It

is also applicable to cases where a large piece is to be cut out, the trephine being applied at the two angles, and the bridge between the perforations divided with the saw. A piece of leather or cork, with a crevice cut in it, is to be placed on the skull, within which the straight edge of the saw is to play, till it cuts a groove sufficiently deep to lodge itself. As the instrument approaches the inner surface of the bone, the circular edge of the saw alone is to be used, as less likely, from the rounded shape of the cranium, to inflict injury on the dura mater. The same precautions as to sounding from time to time, above given, must be attended to, and it will be found better to break the last points of union, than to divide them completely with the saw.

Rasparatory, or rugine.—Rasping or scraping a point of bone with this instrument, or at need with a piece of glass, until the bone is so thinned that an aperture may be formed large enough to admit the point of a lever or a pair of forceps, so as to break out a piece, was formerly recommended, especially in injuries of the head in children. But the practice has justly gone out of use. When it becomes necessary, (which is more rare by far in children than in adults,) to interfere by operation, the trephine is to be preferred if complete ossification has taken place; and in case it has not, the point of the knife or a pair of scissors may supply the place of any other instrument by opening one of the sutures.

3. *Removal of the detached piece of bone.*—It is directed to fasten the bone-screw into the orifice made by the centre pin, and by a few lateral motions loosen and detach the piece. The plan, however, generally preferred, is to apply the elevators on the opposite sides of the piece, so as to detach and lift it out. Occasionally it will be brought away with the trephine. If the edges of the opening left be sharp and rough, they are to be smoothed off with the lenticular knife, or, which answers better, as having less tendency to disturb the dura mater, the point of the common elevator. If there exist the necessity of applying several times the crown of the trephine, (Pl. XXIV. fig. 1,) it should be so disposed as to cut into the space from which a piece had been previously removed, in order to leave but a small osseous angle, which can readily be divided by a Hey's saw or the cutting pliers.

4. *Removal of the cause of compression.*—If there is fracture with depression, the end of the common elevator, or the hook-shaped lever of Græfe, is to be introduced below the sunken piece, which is to be gradually elevated by using the opposite margin of the opening, as a fulcrum for the instrument, or if this be not firm, the finger placed as a bridge across it. To prevent a too sudden elevation, which might detach the piece, it is well to make a little counter pressure on its outer face. If we cannot thus succeed in elevating the fragment, or the inner table is found shattered, it may be removed altogether with a Hey's saw, or another application of the trephine. Loose portions of the bone are to be picked away with the fingers or forceps. But in case one should be imbedded in the brain, and any disturbance of it attended by pain and convulsion, we might imitate the conduct of Sir P. Crampton, and leave it to be detached by suppuration through the external orifice. If the operation has been early done for extravasation or effusion, the fluid, if it lay on the outer side of the dura mater, will usually come away of itself. But if it be coagulated blood, it will require to be broken up with the

finger or probe, and it has even been directed to wash it out with a syringe and warm water. If the dura mater rise as the fluid is discharged it is a happy circumstance. But in none of these cases is the prognosis favourable. If the extravasation extend too far for this rising to be effected, it has been recommended by Sabatier to apply the trephine on another point, on the principle of a counter opening. If the effused fluid lay below the dura mater, this membrane will be found detached from the bone, and of a livid or brownish hue, and in most instances shares less than is natural in the pulsatile heavings of the brain. It is apt also to bulge in the opening and present a feeling of fluctuation below; but this is a sign which might lead into error, for the soft cerebral substance in the healthy state gives on pressure of the membrane a somewhat similar sensation. The presence of the effusion having been detected below the dura mater, this is to be opened, by pushing a straight sharp pointed bistoury obliquely through it; then depressing the handle so as to raise the point of the instrument, the membrane is to be divided in a direction parallel with its vessels. Another parallel puncture, or a cross cut, is usually required. If the operator find the seat of the fluid not on the inner surface of the meninges, but in the substance of the brain—the result usually of a contusion that has terminated in abscess—he may, if, from the change of colour and consistence of the brain and a sense of fluctuation, there be unequivocal evidence of its existence, be justified in following the example of Dupuytren and Begin, and pass a bistoury for an inch even into the cerebral substance, if the fluid lie so deep. The punctures of these surgeons, however, were ultimately followed by death.

In a case of this description, on which I operated during the winter of 1843-4 before the class of the Jefferson Medical College at the Philadelphia Hospital, the altered dura mater puffed up through the opening made by the trephine. On incising this, the softened pulsatious cerebral substance pouted through the orifice, and gave to the finger a distinct feeling of fluctuation below. The wound was lightly dressed, and all proceeding suspended for the time, as life was not immediately in danger, in the hope that the abscess would spontaneously open, which it did on the following day, so as to relieve at once to a considerable extent the coma under which the patient laboured. More or less purulent discharge continued for sixteen days, during which time the patient improved so as to be able to walk about the wards and converse rationally on most subjects. At the end of this period it ceased entirely, and the cessation was followed by a return of delirium, succeeded by coma, of which the patient sunk. On dissection, the orifice in the dura mater, which had not been made sufficiently large, was found blocked up with fungous granulations from its margins, and the cavity of the abscess filling up with pus had opened into the posterior horn of the lateral ventricle, opposite to which the injury had been received and the perforation had been made with the trephine.

5. *Dressing and after treatment.*—The dressing must be light and unirritating. A cribriform piece of linen spread with cerate is to be placed over the opening in the bone, with its angles doubled in, to maintain elevated the flaps of the soft parts, and form a sort of channel for the discharge of the secretions. A pledget of lint or charpie is laid above this, and secured with a

few turns of the roller or *couvre chef* bandage, or even a close fitting cap. The stuffing of the aperture with lint, and the use of thick tight bandages, are to be particularly avoided. Cold fomentations are to be applied to the head, and a rigid antiphlogistic treatment instituted. It is well not to remove the first dressing till it becomes loosened by suppuration. Subsequently the wound should be twice dressed daily. If after the extraction of a fragment, or the evacuation of an effused fluid, the symptoms of compression immediately cease, the parts may be closed with adhesive straps as in ordinary wounds, and reopened again if the symptoms return so as to render it necessary.

If the operation has been done on a young subject, it may happen that a layer of new substance is secreted by the *dura mater*, which will ossify and supply the place of the removed portion of bone. But in the greater number of cases there is a very limited reproduction of bone, a tough resisting membrane supplying its place, through which the movements of the brain may be felt. It has been recommended to wear subsequently over the part, as a protection against external injury, a leather or metal covering.

The trephine has also been employed with advantage in some cases of abscess in the mediastinum, accompanied with caries or necrosis of the sternum. It has also been four times resorted to in injuries of the spine—by Cline, Tyrrel, and Barton. But the result in all save the last case was unsuccessful, and the method can hardly be considered one of legitimate application. In the bones of the extremities the trephine and the Hey's saw become most useful adjuvants in several forms of disease, but particularly for the removal of sequestra in cases of necrosis.

RESECTION OF THE BONES.

The resection of a bone consists of its partial amputation. It is an operation done without destruction to the soft parts, so as to enable us to preserve, to a greater or less degree, the form and usefulness of the part from which the piece of bone is taken. It is in many cases the only alternative against amputation. Though not of particularly recent origin, it has mainly been brought into favour by the address and ingenuity with which it has been practised by modern surgeons. It is an interesting and fruitful department of the art, and under many circumstances becomes the means of saving not only the limb, but even the life of the patient. Operations of this class cannot, however, on account of the varying nature of the causes which render them necessary, and the necessity of their performance at the diseased point, be subjected to the same definite and prescribed regulations as are given for amputation, and ligature of the arteries. The immediate method of proceeding in very many cases must be left to the judgment and ingenuity of the surgeon, and should be adjusted to the character and extent of the pathological changes in the parts surrounding the bone.

The operations for resection may be arranged into three groups.

1. Those which are practised in the continuity of the bones; that is, at some point between their articular extremities.
2. Those in the contiguity, or at the articular extremities of the bones.
3. Those in which a bone is extracted in its whole extent.

Indications.—The causes for which resection is practised are very various.

1. *Caries* of the articular extremities of the limbs, and of some of the bones of the trunk, when all other means have proved insufficient for its cure, and life is endangered by the progress it is making.

2. *Osteo-sarcoma*, *spina ventosa*, *medullary fungus*, and other affections of a malignant character, when they involve parts, as the upper and lower jaw bones, to which amputation cannot be applied.

3. *Compound or comminuted fractures*, in which a fragment has been driven through the skin, and cannot otherwise be replaced in consequence of the obliquity of the fracture, the retraction of the muscles, or the inflammatory engorgement of the surrounding parts; or when a portion denuded of its periosteum has been exposed for some days to the air, and menaced with necrosis. The rule of treatment in such cases is both simple and easy—to enlarge the wound if it be necessary, glide a piece of card or some other means of protecting the soft parts below the bone, and remove the protruding portion with the saw or cutting forceps.

4. *Gunshot injuries* near the heads of the bones, and especially those of the upper extremities. These accidents, even when there has been extensive injury of the soft parts, have furnished again and again, occasion for the most gratifying and successful employment of the resection of the shattered portion, with preservation of the limb.

5. *Compound luxations*; when the period which has elapsed from the occurrence of the injury, or the engorgement and inflammation of the soft parts, or other causes, present an insurmountable obstacle to reduction of the protruded head of the bone. In cases of this sort resection has been many times done with success on most of the bones of the upper extremity.

The end of a bone projecting beyond the margin of a stump after amputation, necrosis, some forms of exostosis, or foreign bodies lodged in a bone, are all causes for which resection can frequently be practised with advantage.

Counter indications and prognosis.—The resection of bones, especially when done for a chronic affection of the joints, constitutes nearly always a long, difficult, painful and complicated operation, in consequence of the anatomical derangement of the parts, the enlargement and preternatural adhesion of the bones, and the thickened and callous nature of the surrounding structures, all which render it difficult to distinguish the vessels and nerves, and produces a greater risk of tetanus, protracted suppuration, fistulous sinuses, purulent absorption, erysipelas, gangrene, and necrosis, than ordinarily follows amputation. In regard to the fitness or unfitness of each particular case for the operation, no precise rules can be laid down. The many and various circumstances of the case, the age of the patient and his powers of endurance, and the particular joint affected, must all be duly considered by the surgeon. Though cases seemingly very unpromising may eventuate well after resection, still not even the hope of saving a limb should lead the surgeon to prefer it to the more simple, easy, and rapid process of amputation, when the patient suffers from one of the cachexiæ, possesses unusual nervous susceptibility, or is in an advanced state of marasmus.

Time of performance.—The time when resection could be prac-

tised with the greatest certainty of success is most frequently allowed to pass by, before the ordinary resources of the art have been satisfactorily tested. As soon, however, as the prospective loss of limb or life becomes apparent to the surgeon, it should be undertaken, for fear that the soft parts should become too extensively involved to subserve the purpose of flaps. Nevertheless it is important to know, that if the tissues be indurated, lardaceous, or even perforated with fistulous openings, they will often, in consequence of the removal of the source of disease and the establishment of healthy suppuration, be afterwards restored to a healthy condition. The elder Moreau believed such a restoration possible, if they possessed even the lowest degree of vitality. But such has not been always the result. The chances of success will vary much according to the condition of the soft parts, as well as to the seat of operation. In the continuity of the long bones, and in the thin or flat, as the shoulder blade, the consecutive inflammation is usually moderate and the cure rapid. In the spongy tissue of the heads of the long bones, and in the bodies of the short or thick, the results of the operation are more to be dreaded, and in a degree proportioned to the extent of structure removed.

Instruments and apparatus.—Besides the ordinary scalpel, there should be at hand a sharp-pointed and a probe-pointed bistoury, a double-edged amputation knife for the larger joints, the common dissecting and torsion forceps, saws of various descriptions, the bone-cutting forceps of Liston and Muller, blunt hooks, a trephine, the mallet and gouge or chisel, rollers, compresses, and strips of leather or flexible splints of wood, card, or metal, to glide between the bone and soft parts in order to protect them against the action of the saw—with sponges, ligatures, and the other necessary appurtenances for ordinary surgical operations. The tourniquet is not usually needed, as the large vessels are to be cautiously avoided, since their division would seriously compromise the success of the operation.

GENERAL RULES FOR RESECTION.

The operation is divided into three stages.

1. *The incision to expose the bone.*—Two objects are to be kept in view—to expose the bone freely with the least injury to the muscles and tendons—and to avoid the route of the great vessels and nerves. For this reason, in operations on the arm and thigh, and over the orbicular joints, the incision is made on the outer aspect of the limb. In the hinge joints two lateral incisions are made, as the vessels and nerves are always found either on the anterior or posterior face of the joint. The incisions, however, must frequently be varied in regard to number, form and extent, according to the size and depth of the bone, and the peculiar anatomy of the region. Considerable difficulty will often be encountered in dissecting the soft parts from the bone, and in isolating the vessels and nerves, in consequence of the thickening, induration, and even partial ossification of the surrounding cellular tissue. If an articular extremity is to be removed, the direction of Professor Syme, (which I find usually the most convenient in practice,) is to penetrate at once into the joint, by dividing at the same time the superficial covering and the ligaments with the knife.

2. *Section of the bone.*—The soft parts are to be separated with blunt hooks, and the diseased heads of the bones loosened with the knife, turned out between the lips of the wound, and divided with the saw or cutting forceps; or if there be a difficulty in turning them out, they may be cut in their bed with the rotary saw of Heine or Charrière, or the chain saw of Jeffrey. In the removal of the detached extremities, the bone screw of the trephine case fastened into the spongy tissue, will furnish a convenient command of the fragments. All the cartilaginous structure of the joint must be carefully removed. If the caries is found to extend beyond the place of division, another portion may be removed, or the advice of Jager followed, which is to apply the actual cautery to the end, in order to arrest the caries by producing necrosis. It will seldom, however, be found necessary, in cases of caries, to remove more than the epiphysis. But if the case be one of caries of the body, or necrosis of the shaft of a bone, the proceeding must be different. The extent of the caries will be determined in a great measure by the separation of the periosteum, which is to be opened, with the overlaying soft parts, by the probe-pointed bistoury, and the bone divided at the height at which the membrane is detached. If the caries involves but a part merely of the spongy structure, it is to be cut away with the gouge and mallet; but it is a law of the first importance when the operation is once commenced, to remove completely all the part actually carious, preserving as far as possible the periosteum. If the case be one of necrosis, the trephine, perforator, or gouge may require to be used, according to the indications already given. In resection of the bones of the fore arm and leg at the ankle and wrist, it will be best in most cases to remove both at the same level, to prevent the subsequent deviation of the limb.

3. *Dressing.*—Union by first intention is seldom effected to much extent. In one instance, however, in which I had resected the elbow joint, it took place except at one point throughout the whole extent of the external wound, and the cure was proportionally rapid and satisfactory. An attempt, therefore, should always be made to accomplish it by closing the wound neatly with the interrupted suture, (to which I give the preference,) or the twisted suture—aided by adhesive straps, compresses, and bandages. The limb is to be steadied in addition with the apparatus for fracture and placed at rest on a bolster or pillow. In the lower extremity, where we desire a solid union, the limb is to be laid out in the straight or extended position. In the upper, the elbow must be flexed, as a position less constraining to the patient, and likely to leave a more serviceable limb in case the operation, if it be at a joint, should be followed by ankylosis. The first dressing should not be disturbed till the purulent discharge renders it necessary. The after treatment must be apportioned to the symptoms that arise. I have derived, it appears to me, very great advantage by keeping the wound steadily wetted for the first week with cold water merely, or a strong lotion of lead water and laudanum, placing the patient during this time under the sustaining influence of opium; thus limiting the amount of constitutional irritation by keeping down inflammation, and obviating one of the chief sources of danger—the development of tetanus.

RESECTION OF THE BONES OF THE TRUNK.

The resection of the bones of the cranium, whatever be the cause that renders the operation necessary,—tumours, caries, or necrosis,—must be practised according to the methods which have been detailed under the head of trephining.

RESECTION OF THE BONES OF THE FACE IN GENERAL.

The upper and lower maxillary bones are far more subject than any others of the pile which constitutes the frame-work of the face, to structural degenerations which render their removal wholly or in part necessary. From the size and complicated structure of these bones, the disease, whether it consists of caries, cancer, medullary fungus, osteo-sarcoma, or tumours of a less malignant character, is very often, even after it has attained great development, comprised within the limits of the lower or upper maxilla. Definite and fixed rules have, therefore, been given for the separate resection of these bones. But in many instances the other bones of the face,—particularly those forming the walls of the orbit and nose, as the malar, the unguis, the palatine, and the lateral portions of the ethmoid,—if not primarily affected, become so involved in the progress of the disease as to require removal. But the intimate connection of these bones, their comparatively small size, and the varying degree of alteration to which they are subjected, renders it impossible to fix any general rule for their removal; the surgeon finding it necessary to modify the set rules or improvise, as it were, a plan suited to the exigencies of each particular case. Instances may occur where the tumour, especially if it have its origin in the upper part of the antrum, will be found developing itself in the upward direction (in which it meets with less resistance), obstructing the cavity of the nostril and pushing the eye from its socket without materially impairing the integrity of the palatine and alveolar processes. In these instances, the outer wall of the antrum has been opened, the contents of its cavity scooped or dissected out, and such parts merely of the bones above and around it as were affected taken away, leaving a part of the upper maxilla to preserve the proportions, and to a considerable degree the usefulness of the jaw.

Tumours of a fibro-cellular character may even grow from the periosteum on the outer wall of the antrum, producing great deformity of the face, without altering the shape or specifically affecting the bones, which require no method more severe for their removal, as has been shown by Dupuytren and Dieffenbach, than simply stretching the commissure of the mouth with hooks, or if necessary widening the opening by an incision, dividing the buccal mucous membrane, drawing down the tumour with a hook and removing it from over the face of the bone.

Frequently, moreover, we meet with instances where the tumour, as in epulis, has had its origin in the gums, or the sockets of the teeth, in which it suffices merely to remove with the saw, or better still with the cutting forceps, the parts immediately involved, not interfering to any great degree with the bony contour of the face, or leaving a greater breach on the side of the mouth than can be hidden by the mechanism of the dentist.

OF THE UPPER JAW. (PL. XXV.)

In most instances, patients afflicted with malignant tumours

of the jaws are unwilling to submit to an operation apparently so fearful as resection, until the upper maxilla of one side has become so much involved, as to require to be wholly taken away, and the other bones of the face so extensively implicated in the affection, that the saw and the bistoury will not alone suffice—the cutting forceps, the gouge and mallet, or the incandescent iron, being required to complete the extirpation, without regard to the anatomical connections of the bones.

General Rules.

There are, however, certain general rules for resection, as applied to any portion of the bones of the face, which must be constantly observed, as far as the nature of the lesion will allow. 1. To avoid injuring the parotid duct, or the branches of the portia dura nerve which give motion to the muscles of the face, by opening the soft parts in a direction as much as possible parallel with their course. 2. To protect from unnecessary injury the facial artery and the infra-orbital and mental nerves. 3. To carry the line of incision or amputation in a part of the bone which is perfectly free from enlargement or other indication of unhealthy action. 4. To tie the arteries, which are commonly small, as they are divided and come into view, arresting the hemorrhage if it be profuse by pressure on the common carotid or the temporal artery, until the ligature can be applied, and using the actual cautery to suppress capillary bleeding as well as to destroy any diseased portion that cannot be reached by cutting instruments.

The great improvement of modern surgery, in reference to undoubted malignant growths of the upper maxillary bone, consists in its amputation entire at its points of articulation, instead of attempting to cut out with saws, forceps and gouges, the diseased mass alone, which process is too apt to leave behind some germ for the future reproduction of the evil. If, by the removal of the maxillary bone, we get rid of the whole site of the disease, the prospect of the return is infinitely less than when we have to attack in addition the palate, unguis and malar bones.

Surgical anatomy.—The upper maxillary is united with the other bones of the face at four separate points, which, though well calculated to support pressure in mastication, may nevertheless be readily separated. But three of these, however, as has been observed by Gensoul, merit the particular notice of the surgeon. 1. Above and in front, where the nasal process of the maxillary joins with the frontal, nasal, lachrymal and ethmoid bones. 2. Upwards and outwards, where it unites with the malar bone, and through this is connected with the zygoma and with the external angular process of the os frontis. 3. In front and below, where it comes in contact with the corresponding maxillary and palate bones. The fourth, where it unites behind with the pterygoid process and the palate bone, presents no obstacle to the separation, yielding readily when the maxillary bone is depressed toward the cavity of the mouth. The arteries divided are small, and consist of the branches of the internal maxillary and the facial. The trunk of the former is not usually injured, but if cut can readily be tied after the removal of the bone. But one important nervous trunk is necessarily involved—the superior maxillary—and the division of this may be readily made, so as to prevent traction upon it, previous to the luxation of the bones.

Methods in general.—Various methods have been employed for laying bare the bone, when the soft parts have not been so involved in the lesion as to determine necessarily a particular mode of incision. If the alveolar margin of the bone only requires to be removed, it will suffice in many cases to draw the lip upwards and outwards, and divide the mucous membrane which attaches it to the bone; and if more space is required in order that the saw or forceps should work with advantage, the mouth may be widened by division of the commissure: or, which is usually to be preferred, the upper lip divided near its middle by a vertical incision extended as far as necessary along the outer margin of the ala, the triangular flap being subsequently dissected off from the bone. It has been advised, if the portion of bone affected be between the

incisor and third or fourth molar tooth, and extends upwards towards the orbit, to expose it by dividing the cheek in the direction of the inner border of the zygomaticus major, from *near* the angle of the mouth upwards and outwards to the margin of the masseter without injury to the duct of the parotid.

If the tumour be broad and the dissection of the soft parts in either direction do not sufficiently expose its surface, a vertical incision through the lip and by the side of the ala nasi may be added so as to form a sort of V shaped flap, which is to be dissected up towards its base. If the disease is located behind the third or fourth molar tooth, the outer incision, instead of passing along the course of the zygomatic muscle, should run out transversely to the masseter, leaving the duct of the parotid on the upper flap.

PLATE XXV.—RESECTION OF THE UPPER JAW.

(Process as employed by Warren, and modified by Velpeau.)

Fig. 1 and 2.—A semilunar incision has been made from the commissure of the lips to the middle of the space between the external canthus of the eye and the point of the ear, as shown in *fig. 3*, and the flap rapidly dissected off from the bones, and reverted with the undivided upper lip upon the forehead, where it is held by the two hands of an assistant (*d* and *e*). The zygomatic process, the external angle of the orbit, the nasal process of the upper maxillary, and the palatine arch between the second incisor and canine teeth, have all been successively divided, and the fat of the orbit carefully detached from the floor of the orbit without injury to the ball. The next stage of the operation is that shown in the figure, in which the surgeon loosens the bone with his left hand, while with a knife in his right he detaches from above downwards the soft parts from the bone on the side of the zygomatic fossa.

f. Section of the zygomatic arch.

g. Section of the external orbital process.

h. Section of the nasal process of the upper maxillary bone.

i. Section of the palatine arch.

j. Eyeball, surrounded with its mass of fat.

k. Maxillary bone, moved by the left hand of the surgeon (*l*) for the purpose of shaking it from its remaining attachments, while it is detached with the knife (*m*) from its connection with the soft parts in the zygomatic fossa.

In *fig. 2*, the surface of the wound is exhibited after the removal of the bone. The space from *n* to *o* shows the portion of undivided lip reflected upwards with the flap.

p. Section of the upper maxillary bone.

q. Palatine arch.

r. Nasal septum, above which are seen the middle turbinated bone and the os planum of the ethmoid.

s. Posterior opening of the nasal fossa, comprised between the septum within, and the zygomatic process without.

t. Border of the temporal muscle.

u. Section of the zygomatic attachment of the masseter.

v. Surface of the tongue.

Fig. 3.—Wound closed after the preceding operation.

Fig. 4.—Closure of the wound, after the removal of the bone by incisions made according to the process of Gensoul.

Fig. 5.—Excision of upper jaw bone, as practised by Lizars, Syme, Liston, and others.

a, b, b. Line of incision of the upper lip, extended from the nostril through the ala of the nose. Liston prefers to make the incision from the margin of the nostril along the line of junction of the ala with the cheek.

d. Horizontal incision from the corner of the mouth. The triangular flap thus formed is to be dissected up rapidly from the face of the bone, and reflected upwards and outwards.

Fig. 6.—View of the parts after the elevation of the flap, formed as seen in *fig. 5*.

a, b, b. Vertical line of incision in the lip and side of the nose.

d. Horizontal incision.

c, e, i. Flap reflected off from the tumour of the maxillary bone (*g*).

h. Nasal process of the upper maxillary bone sawn or cut across with the forceps.

k. Palatine portion of the upper jaw bone, cut through into the nostril after the removal of the canine tooth.

r. The facial artery, divided in the horizontal incision, and secured with a ligature.

Fig 1

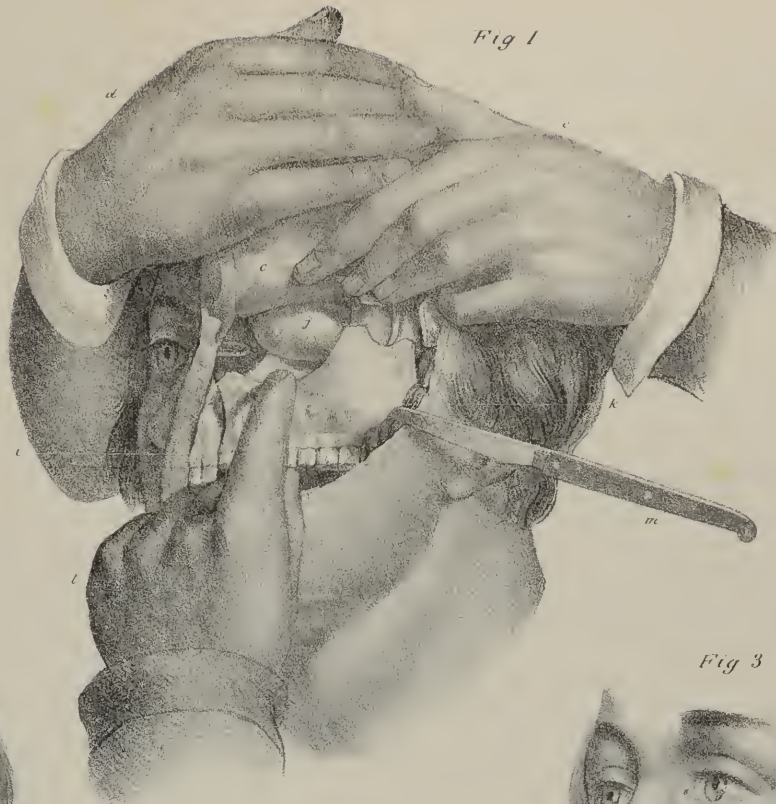


Fig 1



Fig 3

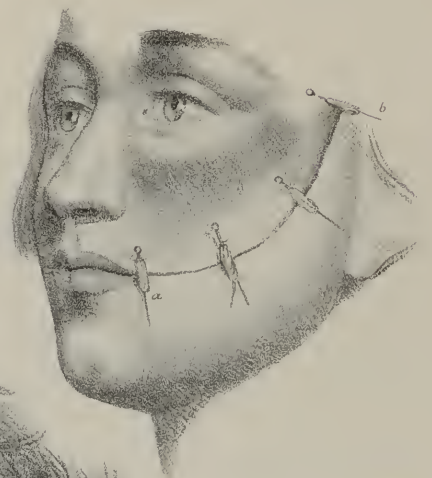


Fig 2

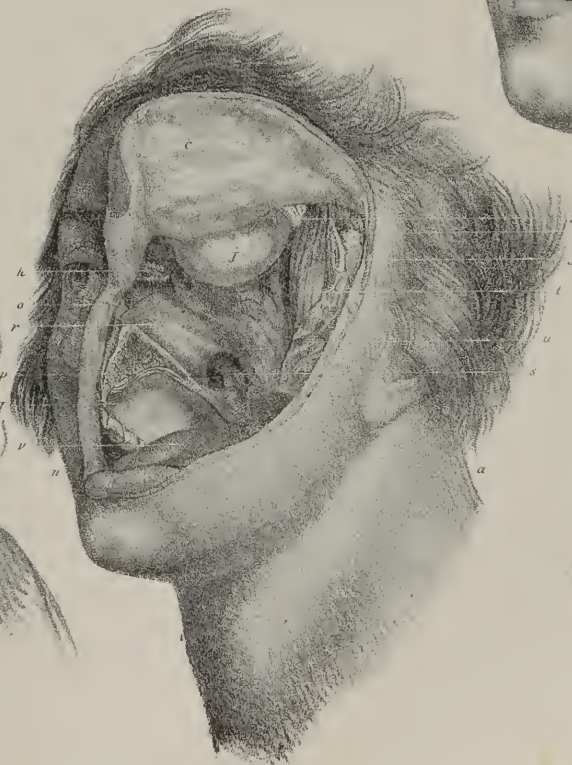


Fig 5

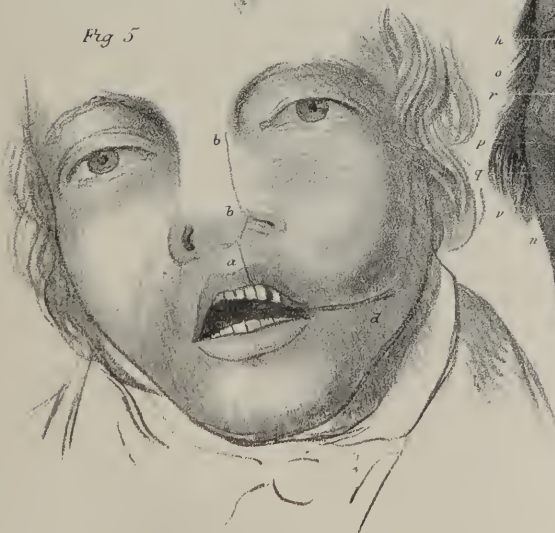
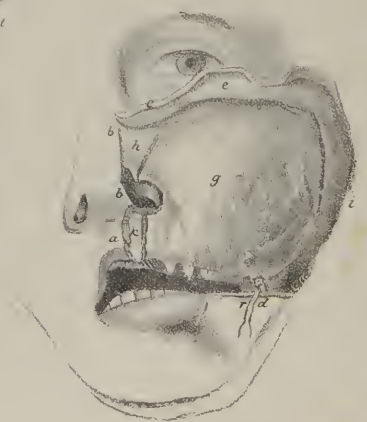


Fig 6



M. Gensoul recommends, especially where the entire bone is to be removed, the formation of a square flap as detailed in the process below.

Mr. Ferguson* advises the V shaped flap above described, with the addition of an incision extended from the external angular process of the frontal bone, towards the neck of the lower jaw, so as to form an outline of this description N. Velpeau has proposed to substitute for the complicated incision of Gensoul a simple division of the cheek, (see Pl. XXV. fig. 3,) extended from the corner of the mouth to the external canthus of the eye, or the region of the temple immediately behind it, leaving the duct of the parotid in the lower flap. The cicatrix following this process is more regular and less deforming than that following the process of Gensoul.

Dieffenbach* has proposed a new method of turning off the soft parts, which he has applied to the resection of the bones of the face in general. Let the seat of the disease be where it may, even if it be in the posterior region of the cheek, he dissects up and throws back a large flap, which is marked out above, by a *horizontal incision passing from one canthus to the other, leaving entire the lower eyelid*, and on the median line by a vertical incision through the middle of the upper lip and over the back of the nose, through both skin and cartilage, so as to divide the nose into two equal parts. Care must be observed to preserve the conjunctiva with the upper lid; and, in dissecting at the internal canthus, to separate the tissues from the bone, in a way to avoid all injury of the lachrymal passages. In dissecting back the flap, the infra-orbital nerve is the only part of importance divided; but although the facial nerve, the duct of the parotid, and the facial artery, are preserved uninjured in the thickness of the flap, it is very questionable whether, from the risk of injury to the eye, and of the chance of deformity in reconstructing the nose, it will ever be much employed by any other surgeon.

Process of Gensoul. (Pl. XXV. fig. 4.)—The patient is to be seated on a low chair, with his head thrown back and sustained against the breast of an assistant. A vertical incision is to be dropped from near the inner canthus of the eye, so as to divide the upper lip completely through over the dens caninus. A second transverse incision is to be carried outwards from this, commencing on a level with the nostril, and terminating a third of an inch in front of the lobe of the ear. To the outer end of this incision a third is carried down nearly vertically, beginning at a point about half an inch to the outer side of the external canthus. The whole side of the face is thus divided into two flaps; the upper one, which is square, is to be dissected and turned over the forehead, and the lower, somewhat triangular in shape, reversed merely upon the angle of the jaw. The bone is now fully exposed. If a portion only is to be taken away, it may be done with a knife if the bone be soft, or by the use of a Hey's or a narrow-bladed saw, the strong cutting forceps, or, if need be, the mallet and chisel. But if it requires to be taken away entire, it will be necessary to detach it with five blows with the mallet and chisel, or as many applications with the cutting forceps, which will usually be found to answer the purpose as effectually and with less shock to the brain. First, we divide the union of the malar bone

to the external orbital process of the os frontis. Secondly, the zygomatic process of the malar bone. Thirdly, the os unguis and the nasal process of the upper maxillary. Fourthly, all the soft parts uniting the ala of the nose to the bone; removing the first incisor tooth of the same side, and entering a chisel at this point, but in the direction of the eye, of the affected side, so as to separate the diseased bone from the place of junction with the one of the other side. (The maxilla is now loosened at its three principal points of attachment, and is held by no other bones than the palatine and the pterygoid process of the sphenoid.) Fifthly, the chisel is to be directed obliquely upon the floor of the orbit from above downwards and before backwards, in order to destroy its connections with the pterygoid process, to divide the upper maxillary nerve, and at the same time gain a point of support, so as to poise the loosened bone over in front. The surgeon has then only to divide with the curved scissors or bistoury the soft parts connected with the bone, and especially the attachments of the velum palati to its lower and back part, as the velum should be left entire. The mass of bone, which now readily comes away, consists of the upper maxillary and the malar bone, and a part of the unguis, ethmoid, and palatine. A large excavation is left, (Pl. XXV. fig. 2,) limited within by the septum of the nose, without by the buccinator muscle, above by the inferior rectus muscle of the eye, (the origin of which has been divided,) and the fat of the orbit, communicating below with the mouth, and behind with the pharynx, above the velum palati. This operation, formidable as it appears, may nevertheless be quickly done. Gensoul has operated in eight cases without losing a patient; and in one instance the removal of the bones was effected in two minutes and a half. It is seldom that more than one or two small arterial branches require to be tied. Necrosed portions of bones will be frequently thrown off for some time after the operation. More or less paralysis of the face follows, a result which can only be avoided by opening the soft parts after the manner of Dieffenbach.

Dressing. (Pl. XXV. fig. 4.)—The wound is kept open for half an hour or an hour, in order to allow the capillary bleeding to cease, and to facilitate, according to Dieffenbach, union by first intention. If there is any morbid or even suspicious tissue left after the removal of the bones, the actual cautery is to be used to destroy it. If it be found even on the under surface of the flaps, Dieffenbach does not hesitate, when it can be removed by this means, to pass the cautery rapidly over it, in preference to removing any portion which would increase the amount of the deformity. The flaps are to be brought together with the twisted suture, and the parts supported according to the direction of Velpeau, by a retaining bandage. Cold applications are to be made over the face. The bones left, will gradually approximate during the progress of the cure, and the deformity following the operation will be much less than would be previously supposed.

A troublesome incident during the operation is the fall of blood into the throat, and it is for the purpose of obviating this as much as possible, that the patient is placed in the sitting posture, and that the detachment of the bone is commenced on the side of the cheek. The cavity between the tongue and the eyeball is to be lightly filled with lint or charpie, (to prevent the latter sinking too low,) and withdrawn at subsequent dressings through the orifice of the mouth.

* Practical Surgery, Amer. edit., p. 520.

† La Chirurgie de Dieffenbach, par Ch. Phillips, Berlin, part. I. p. 122, 1840.

Process of Lizards. (Pl. XXV. figs. 5 and 6.)—The surface of the bone is exposed up to the margin of the orbit, by the elevation of the triangular flap, referred to at page 110, formed by a horizontal incision from the mouth and a vertical one through the side of the nose and the upper lip. The soft covering of the bone is then to be divided at the parts where it is to be sawed, by applying the knife—first, upon the floor of the nostril; secondly, over the nasal process; thirdly, upon the gum and mucous membrane of the mouth near the palatine suture, keeping in view the

preservation of the palatine plate of the palate bone; and lastly, round the bone on the side of the pterygoid fossa. The nasal, the malar, and palatine processes, are now to be notched with a saw. One blade of a large pair of cutting forceps is introduced into the nose, and the other into the orbit, so as to divide the nasal process of the maxillary bone. The connection of the maxillary with the malar bone is then separated in the same way; and finally, after having removed one of the incisor teeth, (provided it had not previously come away,) the alveolar process and

PLATE XXVI.—RESECTION OF THE LOWER JAW.

(Fig. 1.) RESECTION OF THE CHIN.

This portion of the bone alone being diseased, the middle of the lip has been divided in the middle line, and the section continued down to the os hyoides. The flaps have been dissected off and reverted, and the two canine teeth extracted, to give passage to the saw with which the jaw is divided vertically on either side of the chin. Previous to detaching the piece, a fine silver wire has been passed through the substance of the genio-hyoglossus muscles, in order to prevent the convulsive retraction of the tongue backwards. In the stage of the operation shown, an assistant holds the wire thread (*a*), while the surgeon draws downward with the left hand (*b*), the fragment of the jaw, and with the bistoury (*c*), is about to divide the insertions of the genio-hyoglossus, and genio and mylo-hyoid muscles.

(Fig. 2.) RESECTION OF THE BODY OF THE LOWER JAW ON THE LEFT SIDE.

The points for dividing the bone being at the canine tooth of the same side, and at the origin of the ramus, a vertical incision (*a*) has been made through the lip to the base of the chin. Another incision (*b*), starting from the middle of the posterior part of the ramus of the jaw, is carried first down to the angle, and then along the base of the jaw to the vertical incision at the chin. The flap (*c*) has been dissected off from the bone, and reflected upward upon the cheek. The first molar tooth has been removed to give room to the saw in dividing the bone. The bone has next been separated by dissection from the soft parts on its inner face, and a guttered instrument (*e*) passed below the bone, on the groove of which the chain saw of Jeffrey has been passed, as seen in the drawing, for the purpose of making the last section of the bone.

(Fig. 3.) RESECTION OF THE WHOLE LOWER JAW.

A single incision, commenced below the lobule of the ear at the posterior part of the ramus of the jaw of one side (*a*), has been carried first down to the base of the jaw of the same side, then around the base (*b*, *c*), and ascending on the ramus of the opposite side, to a height corresponding with its place of commencement. The facial artery will be divided in this incision, and must be secured with a ligature. The immense flap (*d*) thus circumscribed, is dissected from below upwards off from the bone, loosening it first in its middle portion, and then on its sides, by cutting the attachments of the masseters (*e*). The flap is then reversed upon the face, so that the edge of the lower lip (*f*) becomes inverted. The jaw is next isolated below and within by dividing the platysma muscles (*b*, *c*), and the mylo-hyoid (*g*). Then, before cutting the attachments of the tongue, a well annealed silver wire is passed through the substance of the genio-hyoglossus muscle, brought out between the lips, and given in charge to an assistant; after which the attachments of the tongue may be divided with impunity. The jaw thus isolated on its inner side, is sawed through at the symphysis, to facilitate the disarticulation of each branch. In the drawing, the left half has been already removed, and the right, forced outwards, displays the gutter (*e*) from which the jaw has been removed, the under surface of the tongue (*m*), the sides of the tongue (*n*), placed within the upper dental arch, and the section of the left pterygoid muscles (*o*). Between these muscles the trunk of the internal maxillary artery has been tied, so as to prevent hemorrhage from its various branches—the inferior dental, the masseter and pterygoid, which have been cut in the operation. The assistant, who holds with his hands (*p*, *p*) the flap, is to make pressure previously on the trunk of the carotid artery till the stage of the operation arrives in which the internal maxillary can be secured. In the last step of the operation, as represented in the drawing, the surgeon, after having isolated the coronoid process, forces out the right half of the jaw with one hand, while he divides with the knife in the other, the insertion of the internal pterygoid near the condyle, which presents the last obstacle to the disarticulation of the bone.

Fig 1

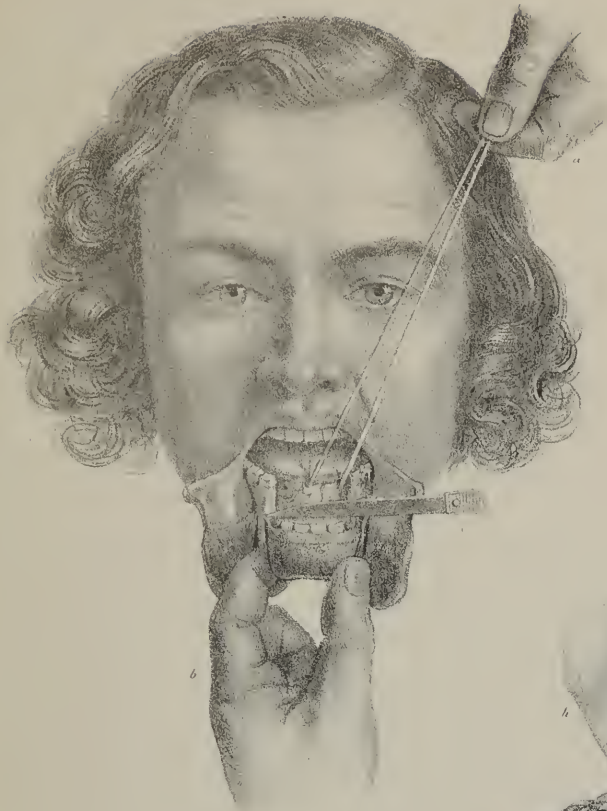


Fig 2

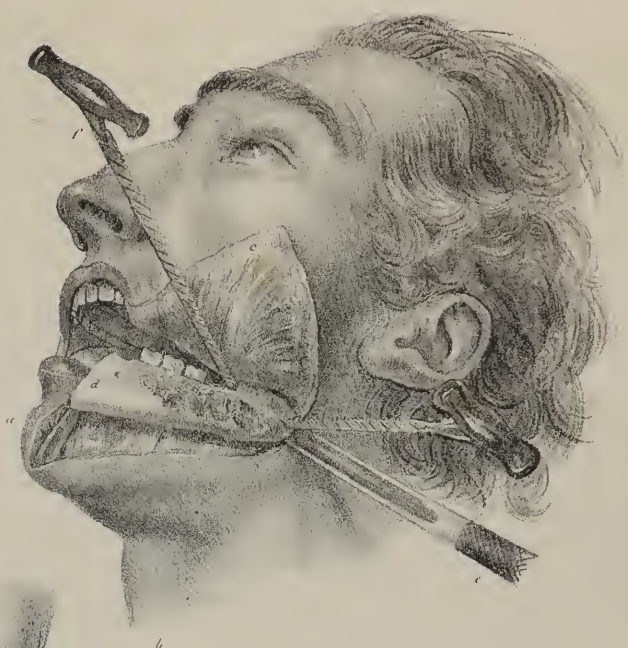
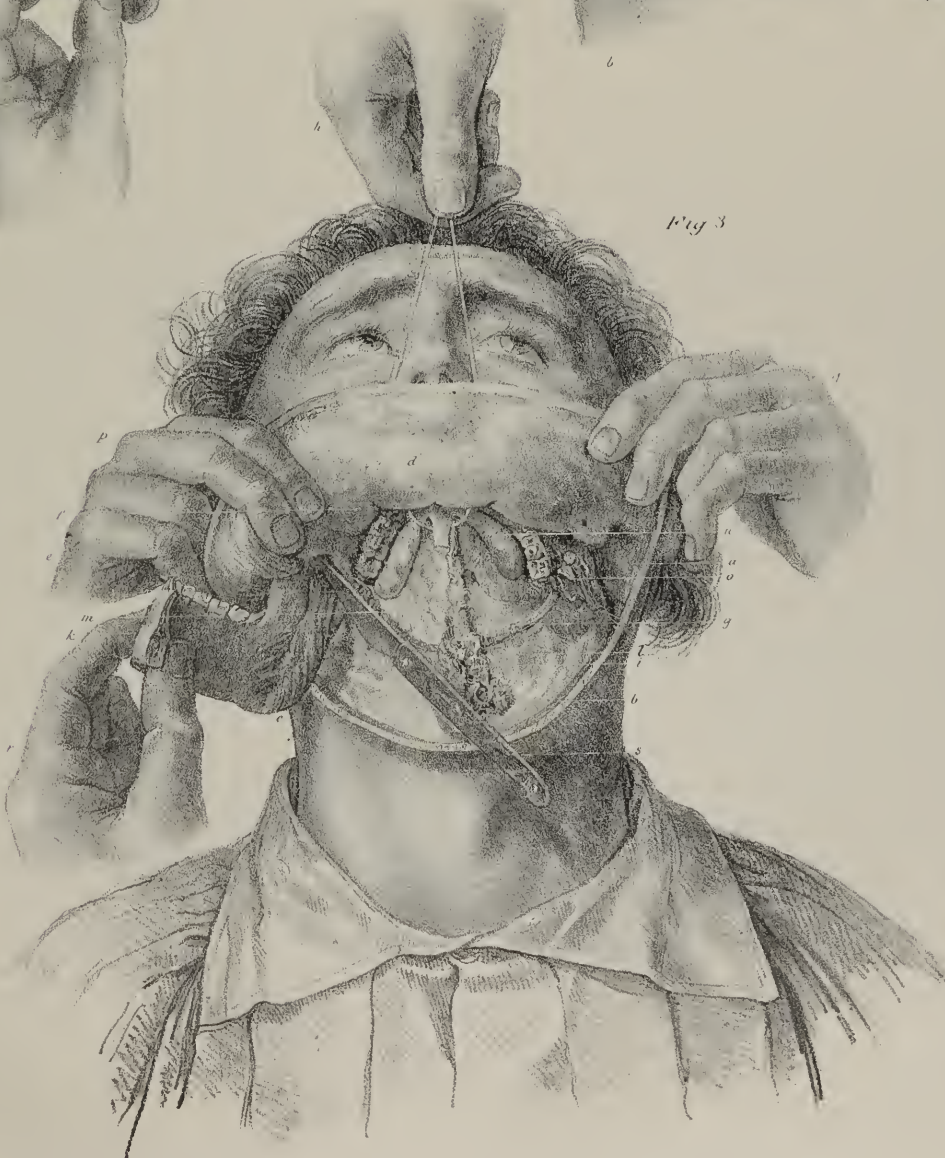
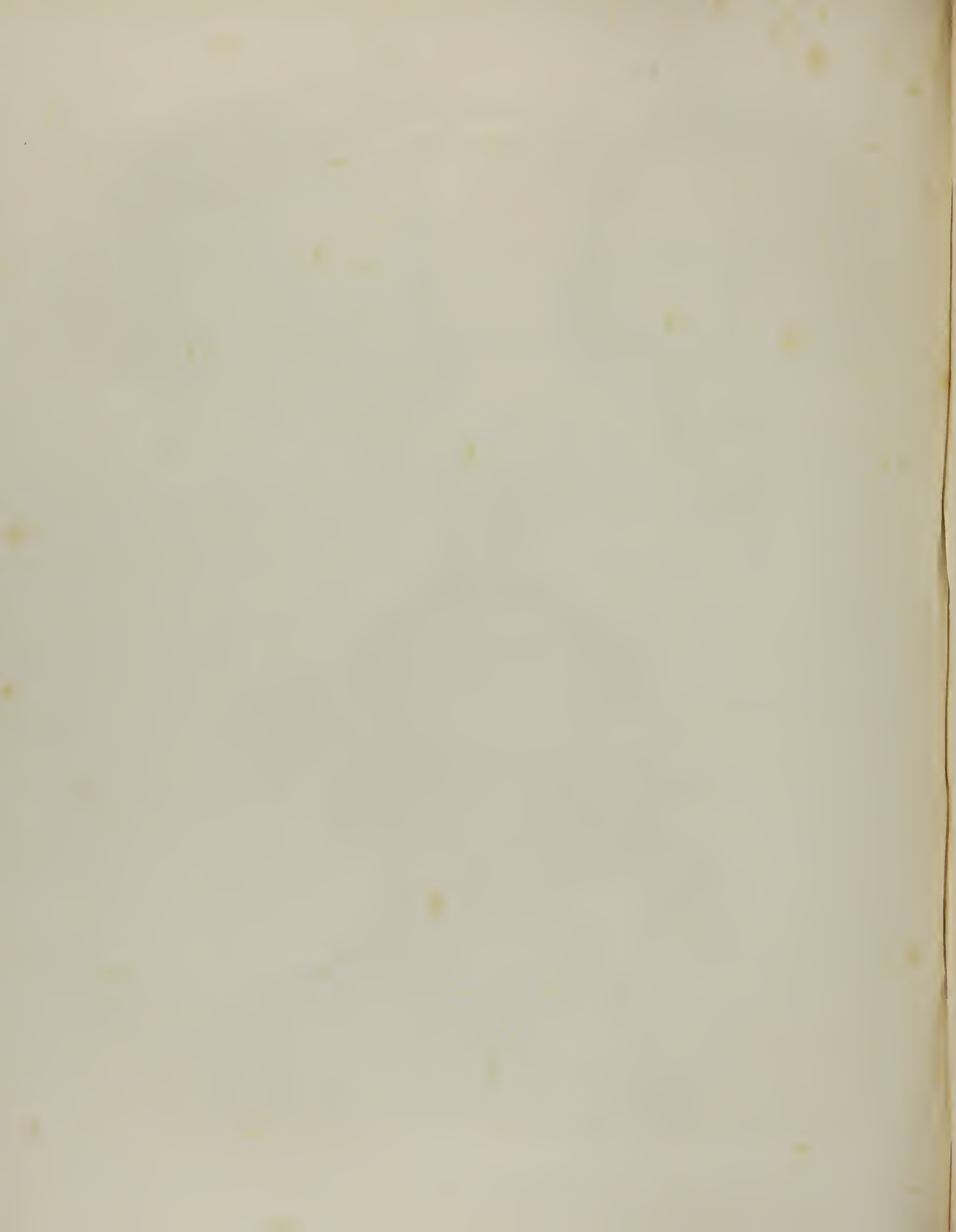


Fig 3





palatine plate is to be similarly divided near the point at which the two maxilla come into conjunction. The principal attachments of the bone being now destroyed, its removal is to be completed as in the process already described. In large tumours of the bone, this incision of the soft parts will not be found to give the surgeon sufficient freedom.

The process of Mr. Liston for exposing the bone in cases of large tumour, is somewhat different. He forms his flaps by three incisions; one of which extends from the external angular process of the frontal bone, through the cheek to the corner of the mouth, one along and down the zygoma at right angles to this, and a third from the nasal process of the maxillary bone, dividing the ala from the bone at its connection with the cheek, and passing through the middle of the upper lip.

Professor Ferguson, after turning off the soft parts, by a flap formed by the vertical incision of Liston, and a semilunar one from the corner of the mouth, which terminates on the zygomatic process of the malar bone, directs first a division of the mucous lining of the hard palate, on the diseased side of the median line, as far back as the velum which is also to be separated on the same side from the hard palate. The alveoli and palatine plate are to be deeply notched from below upwards with a small saw, near the median line, and the section completed with the cutting forceps. If the malar bone and the orbital plate of the maxillary are sound, neither is to be removed. A notch is to be made across with the saw from the nasal process of the maxillary to the outer margin of the malar bone, and the forceps used as before to complete the separation, as well as to divide the nasal process of the maxillary. But if the orbital plate and malar bone are diseased, the forceps are employed to divide the different attachments of the bones, at the points indicated in the process of Gen-soul.

If the reflexion of the triangular-shaped flap in the preceding process does not sufficiently expose the bone, Mr. Ferguson makes another cut from the external angular process of the os frontis in the direction of the neck of the lower jaw, so as to fall upon the outer end of the incision from the corner of the mouth.

Process employed with success by Professor Warren and M. Velpeau.* (Pl. XXV. fig. 1.)—This process is of all others attended with the least mutilation of the soft parts of the face. It affords in all ordinary cases sufficient room for manipulation on the bone, and is therefore when applicable entitled to a preference. A single semilunar incision is extended from the temporal margin of the outer canthus down to the angle of the mouth. The large flap thus marked out is dissected up rapidly from the face of the bone, and the ala of the nose detached at its roots so as to admit of being drawn upward with the rest of the flap toward the forehead, as shown in the plate. At the lower part of the wound, the soft parts are to be dissected off and turned downwards, so as to expose the malar and maxillary bones as far back as the pterygoid processes of the sphenoid. The origin of the inferior rectus muscle of the eye and the parts surrounding the ball, are to be carefully separated from the floor of the orbit. The subsequent detachment of the bone is made with the aid of the saw and forceps, nearly as in the manner already described.

In a case of extensive cancer of the jaw, M. Velpeau followed, however, more nearly the process of Dieffenbach. He made a horizontal incision an inch long, from the external canthus of the eye to the zygomatic arch. A vertical one was dropped from the inner angle of the eye, which divided the soft parts covering the back of the nose and the middle of the upper lip, exposing the cavity of the nostril. Joining then the two incisions at their upper part, he lowered the inferior eyelid by dividing the conjunctiva at its point of reflexion along the inferior margin of the orbit. He dissected the flap from above downwards, and reversed it in the direction of the angle of the lower jaw. The zygomatic process was then divided with a chain saw, and the malar bone cut with a chisel near its junction with the orbital process of the os frontis. An incision was next made through the velum palati for the passage of one end of the chain saw, which was drawn outwards; and the arch of the palate severed with this instrument from before backward. The nasal process of the upper maxillary was divided with the cutting forceps, and the maxillary bone wrenched from its connections with the palate bone and the pterygoid process. The operation was successful.

RESECTION OF THE LOWER JAW. (PL. XXVI.)

The resection of the lower jaw, either in half or smaller portions, is with proper precaution an easier and less formidable operation than that of the upper.

Partial resection.—The partial resection of the lower jaw has been many times successfully performed, without leaving any great deformity of the face, or much defect in speech or deglutition. Of one hundred and sixty cases collected by Velpeau, one hundred and twenty have been reported as successful.

a. Resection of the chin.—When it has been necessary to remove only the gums and alveolar processes of this region I have been enabled to sufficiently expose the bone by dissecting the under lip off from the gums, and having it strongly drawn downwards by an assistant. But if the tumour project much laterally, it will be necessary in addition to extend one or both of the commissures by an incision. The two teeth corresponding with the outer margin of the disease, are then to be removed if they have not previously fallen out, and the surgeon standing behind the patient, divides the alveoli vertically at these points with a strong pair of straight cutting forceps; but if angular forceps be used, he may keep his position in front. With a pair of large and strong cutting nippers, applied so as to grasp the bone anteriorly and posteriorly, the piece is detached. A Hey's saw, or that of Barton, may be made to serve in place of the former instruments. The wounds in the lip are to be closed with the twisted suture. If the whole mental protuberance be involved, the following method is to be employed.

Ordinary process. (Pl. XXVI. fig. 1.)—The patient is to be seated; for in this position he is less exposed to the feeling of suffocation from the blood flowing back into the throat, or to the convulsive retraction of the tongue when its anterior attachments are divided, which is the most serious inconvenience attendant on this operation. The facial artery should be compressed under the angles of the jaw, as directed at page 32; the head of the patient should be placed against the breast of an assistant, and his legs rested over the top of a stool, so as not to furnish a point of

* Vide Walsh on Cancers, with additions by J. Mason Warren, M. D. Boston, 1844.

support sufficiently firm to enable him to raise from his position during the operation.

1st step.—The lower lip is grasped at either commissure by the surgeon and his assistant: it is drawn upwards so as to make it tense, and at the same time held outwards from the jaw. It should be divided with a single cut, in the middle line, and the incision subsequently extended down through the skin and cellular tissue merely, to the top of the *os hyoides*. The lip is now to be detached to the right and left from the surface of the bone, and the flaps held outwards and upwards by assistants.

2d step.—The limits of the disease are now to be carefully ascertained, the periosteum divided on the points at which the section is to be made, and the corresponding teeth removed, so as to favour the action of the saw. The bone is then to be deeply notched from above downwards with one of the small saws previously mentioned, the tongue and the soft parts behind being protected by a piece of pasteboard or leather, a spatula, or, which I have found sufficient, the finger of the surgeon. If the saw is used only in the vertical position, the surgeon places himself so as to lean over the patient. It is not necessary to do more on either side than notch the bone deeply with the saw, as the remaining part may be readily divided with the forceps. If the chain saw is used, it is to be passed round the inner surface of the bone, through an opening previously made for it with the bistoury or by means of a broad curved needle. If the disease will admit it, the bone is always to be divided on the inner side of the mental foramen, in order to spare the nerve which this orifice transmits. If possible, the bone is also to be sawed through obliquely, so as to remove less from the inner than the outer side.

3d step.—*The removal of the piece.*—The surgeon, standing in front, passes from below upwards, behind the bone, a sharp-pointed bistoury, with which he carefully shaves the inner surface from left to right, so as to divide all the muscles and soft parts connected with it, the tongue being held back as above directed, to keep it from coming in contact with the knife. As soon as the muscles of the chin are severed for the purpose of detaching the bone, the stylo-glossus and genio-hyoglossus muscles draw the tongue strongly backwards, so as to involve, if their action is not resisted, a risk of suffocation by closing the glottis. Magendie lost a patient under such circumstances, and Lallemand in another instance was compelled to resort to tracheotomy. This distressing symptom, attendant on the contractile effort of these muscles, usually however quickly disappears, especially if the head be inclined forwards. Nevertheless it is best to obviate it by causing an assistant to seize it with a towel or a pair of hooked forceps and hold it for a few moments; or, which is to be preferred, with a ligature as advised by Delpêch, previously passed through its point or frenum. When the chin can be tilted forwards the muscles can sometimes be conveniently detached from the bone, by dividing them from above downwards. Any diseased glands in the vicinity are also to be removed.

4. Dressing.—The wound is to be sponged clean, and the bleeding arteries tied. If hemorrhage occurs from the dental artery, the orifice in the bone may be stopped with a plug of wax. If bleeding continues from the spongy tissue below the tongue, and the arteries have retracted so as not to be discovered, the surface is to be touched with the heated iron. The flaps are to

be brought together and secured with the hare-lip suture. It is usually recommended to introduce a mesh of lint or charpie into the bottom of the fissure, in order to give vent to the secretions which follow; but this is a measure of doubtful utility. It is directed by Delpêch to bring the thread which has been passed through the frenum between the flaps, and secure it to one of the hare-lip pins, until the tongue has had time to form new attachments. To prevent the falling of the sides of the bones inwards, Mr. Nasmyth, of Edinburgh, has devised an ingenious little instrument—a double silver case to contain the upper and lower molar teeth, which should be made to fit on, previous to the operation. Each step of the usual operation here described, may require to be more or less modified, to suit the exigencies of particular cases. If the disease of the bone be too extensive to admit of its being thoroughly exposed by the triangular flaps formed by the vertical section of the lip, it will be necessary to divide the parts by an incision in the shape of the letter J reversed, the base running along the under surface of the chin, and dissect up a quadrilateral flap on either side. If the disease is cancerous, it will usually be found to have commenced upon the lip, and therefore necessitates the removal of a portion of the latter in a V shaped flap, the apex of which shall point toward the *os hyoides*. If the entire lip is so involved in the disease, or a considerable portion of the cheek, as to require to be taken away, the breach is to be filled up by one of the plastic processes hereafter to be described, and the success of the case will depend very much on the ingenuity and skill with which the surgeon accomplishes the latter proceeding. When merely the anterior or external table of the bone is invaded by the disease, the posterior part may be left, as directed by Delpêch, to preserve the normal contour of the jaw, and the attachment of the lingual muscles. When it has been necessary to remove a considerable portion of the bone, the flaps will be found occasionally too large to make a neat closure of the gap, and it will become necessary to retrench them by the removal of a V shaped portion. Gensoul recommends that this should be taken off by an oblique cut from the margin of one of the flaps only, so as to get a lateral cicatrix, and thus avoid the tendency which a directly linear cicatrix has to gradually lower the lip by its long continued retraction. In my hands, however, this has not proved a very satisfactory modification, as it only in part accomplishes the object, and distorts more or less one of the angles of the mouth. In favourable cases, and when but a small portion of the bone has been removed, the two ends will become solidly united together. When the interval left between the extremities is of considerable size, granulations may shoot out from the divided surfaces, forming a fibro-cartilaginous band of union, which subsequently becomes solidified by a deposit of calcareous matter, so as to restore the usefulness of the jaw in mastication. In cases where solid union cannot be brought about, the patient will be compelled to restrict himself to the use of liquid aliments.

b. Resection of the horizontal portion of one side. (Pl. XXVI. fig. 2.)—The nature and degree of alteration of the soft parts may render necessary some peculiar form of incision for uncovering the bone. But when the bone alone is the part principally affected, one of the four following processes may be employed.

1. Process of Cloquet. *Formation of an inferior square-shaped flap.*—The cheek is to be divided with a knife or strong pair of

scissors, from the corner of the mouth horizontally backwards to the posterior border of the ramus of the jaw. From the extremities of this, two vertical incisions are to be dropped; one in front to the base of the jaw—one posteriorly, descending from behind the ramus of the jaw to a few lines below the angle. The flap thus marked out is to be dissected off from the outer face of the bone, and reversed from above downwards. The tongue is then to be detached from the alveolar ridge, and the bone cut across, first at the symphysis and afterwards at the origin of the ascending ramus.

2. *Process of Mott. Formation of two flaps.*—A semilunar incision, convex posteriorly, was made by this surgeon from over the temporo-maxillary articulation, and terminated upon the chin below the labial commissure. From the posterior and upper end of this incision, another was carried downwards to the back part of the angle of the jaw, and for a little distance along the anterior border of the sterno-cleido-mastoid muscle. Two flaps are thus formed; the superior, which is semilunar, is to be dissected and turned upwards—the inferior, or triangular, raised and turned downwards. The outer surface of the bone is now fully exposed. After dividing the inferior dental nerve at its place of entrance into the bone, and pressing the lingual nerve inwards, the resection of the bone is to be made.

3d *Process.*—An incision is to be dropped from the corner of the mouth to the base of the jaw; from the lower extremity of this, another is to be carried along the base of the jaw for a quarter of an inch beyond its angle, when it should be curved for half an inch in the direction of its ramus. The flap is to be dissected loose from the bone, and drawn upwards and backwards by an assistant—and the facial artery, which had been previously compressed, secured by a ligature. This process, when the tumour is not too large, or the integuments extensively diseased, has incontestable advantages over the others, as the flaps after the removal of the bone, fall so neatly into place, as to be followed by little deformity. In each of the processes it is necessary to divide the attachment of the masseter and internal pterygoid muscles upon the jaw, as well as the trunk of the inferior maxillary nerve, previous to severing the bone at either one of its extremities, with the saw or forceps. The section is made in the body of the bone, much in the same manner as directed for resection of the chin. The attachment of the genio-hyoglossus muscles is not in this operation disturbed, and there will consequently be no doubling back of the tongue. A deviation of the chin to the opposite side is, however, almost inevitable.

c. *Resection of the horizontal portion of both sides.*—An incision is to be carried horizontally along the inferior border of the maxillary bone and round the chin, from one angle of the jaw to the other. The large flap thus formed is to be dissected loose from the bone, and raised upwards by an assistant. After having separated the muscles from the posterior part of the bone, as described at page 114, the bone is to be divided in the manner and with all the precaution detailed in the preceding pages. If the tumour is very large it will be found very convenient to divide the flap into two portions, by a vertical section of the lower lip.

d. *Resection with disarticulation of one-half of the lower maxillary bone.*—The form of incision must of course vary according

to the size of the tumour and the condition of the integuments covering it.

Mr. Liston*, in order to prevent to a great degree the scarring of the face, advises, as the *general rule*, in all resections of the lower jaw, an incision entirely underneath the jaw, without dividing the aperture of the mouth at all. He puts in the point of the knife and brings it down over the ramus of the jaw in contact with the bone, and then finishes the incision by extending it under the base to the point of the chin. The integuments, muscles and membranes of the mouth are then raised from the point of the bone in one flap. The knife is then passed in behind the symphysis with the finger in the mouth and carried along so as to detach the soft parts on the inner part of the jaw. He then proceeds to resect the bone.

In many cases, however, especially where there is great enlargement of the bone, the following plan, as practised by Cusack and Lisfranc, will be found to answer well. Divide the integument along the base from the symphysis of the jaw to the angle. A vertical incision is then to be made through the middle of the lower lip to the anterior extremity of the first. Another incision, descending from the zygomatic arch behind the ramus of the jaw, falls upon the posterior termination of the horizontal cut. The facial artery is to be tied, and the four-sided flap thus formed is to be dissected and turned upwards and forwards, carefully avoiding all injury of the parotid gland and duct. The maxilla is then to be divided with the saw and forceps at the symphysis, and the soft parts detached as far back as the angle, by shaving with the bistoury the posterior face of the bone. The masseter is to be loosened from its attachment to the jaw. The temporo-maxillary articulation then comes into view. A button or probe-pointed bistoury is now to be passed behind the coronoid process and below the zygomatic arch, in order to divide the tendon of the temporal muscle; the jaw being lowered at the same moment, so as to bring down the coronoid process and effect the luxation of the condyle. Carrying next the blade of the knife along the upper surface of the fossa between the coronoid and condyloid processes up to the articulation, the external pterygoid muscles and the articular ligaments are to be cut, the bone being drawn well forwards at the same moment, so as to remove it as far as possible from the vessels which lie behind the ramus. The condyle is then to be pushed outwards and the knife passed through the joint, to divide the internal lateral ligament and a portion of the internal pterygoid muscle. This step of the operation is the most difficult. A great number of vessels will be cut, some of which require to be tied, before the operation is completed. The fear of wounding the internal maxillary, which winds round the neck of the jaw, has induced Græfe, Dzondi, and others, to tie the external carotid previous to commencing the operation; whilst most other surgeons consider the precaution useless and ineffectual, and prefer to tie the arteries as they are cut.

e. *Removal of the entire lower jaw.* (Pl. XXVI. fig. 3.)—This is said to have been once successfully effected by Walter, of Bonn, the *patient recovering without any permanent difficulty in respiration or deglutition*. A horizontal incision is to be traced around the base of the bone, extending from one angle of the jaw to the other. A descending incision, parting from the root of the zygomatic arch behind the ramus, is to be dropped on either side, so as to meet

* Lectures on the operations of surgery.—Lancet, April, 1845.

the posterior extremities of the first. The huge flap thus formed is to be dissected loose from both sides of the jaw, and raised up over the face like a mask, as directed for the removal of the body of the bone. The maxilla is then to be divided at the symphysis, and each half loosened and disarticulated, as described in the preceding article. But one case only has been reported, and that but imperfectly authenticated, of this frightful operation, which has been well described by Vidal as the *ne plus ultra* of the surgeon. It is difficult to conceive of any affection, save that of a wound from a grape shot or a cannon ball, that could render it in the estimation of a judicious practitioner at all justifiable; for a morbid affection which had gradually involved the entire bone to such an extent as to render any other process inapplicable, could hardly be expected to have left the parts within its arch, or the

integuments covering it, so free of disease as to furnish a rational prospect of cure.

f. Resection of one of the margins of the jaw. (Process of Barton.)—The alveolar margin of one or both sides of the jaw, if alone involved in the disease, may be removed successfully without destroying the continuity of the bone.

The great advantage to be derived from this form of partial resection, in cases that allow of its performance, consists in the preservation of the parabolic form of the jaw, the complete retention of its uses as a lever, as well as a more speedy cure and a diminution of the deformity that attends the removal of any portion of the base. The soft parts are to be opened by a vertical incision through the lip, and a horizontal cut at the base of the jaw. The flap is to be dissected upwards, and the alveolar

PLATE XXVII.—RESECTION OF THE RIBS, SCAPULA AND CLAVICLE.

(Fig. 1.) RESECTION OF THE RIBS.

The operation at the upper part of this figure is supposed to be practised upon a woman after the removal of a cancerous breast—the malignant affection having extended so as to involve the pectoral muscle and the anterior portion of the third and fourth ribs. Under these circumstances, it is easy without increasing the external incision, to resect portions of the subjacent ribs. In the stage of the operation shown in the drawing, the surgeon, after having made the outer section of the ribs, raises the fragments with his left hand (A), and having divided the intercostal muscles, detaches the portions of the two ribs by another cut, near the junction with their cartilages. To protect the pleura from the action of the saw (B), a greased compress (C) has been introduced below the ribs, where it is sustained by the fingers of an assistant. The very common tendency of cancer of the breast to return after operation, especially where it has involved parts beyond the structure of the gland, will seldom justify any attempt for its removal when either the muscles or ribs are implicated.

- 1, 1. Line of incision through the integuments.
- 2, 3. Section through the pectoralis major and minor muscles, the diseased portion of which in front of the ribs has been removed.
4. Perpendicular cut of the great pectoral muscle on the side next the axilla. In many cases it will be necessary when the operation is undertaken, to remove this portion of the muscle, and prolong the incision of the skin towards the axilla, so as to remove the lymphatic glands, if these have been implicated in the disease.
5. Fifth rib, which is supposed to be healthy.
6. Place of the section of the two diseased ribs.
7. Fragment of the ribs united by the interosseous muscle and fascia, which have suffered from the disease.
8. Surface of the costal pleura, below the portion to be resected.
- 9, 10. Ligature of the thoracic and intercostal arteries.

The lower operation upon this drawing represents the partial resection of the ninth rib for caries, as practised by the author during the winter of 1842-3. An incision of the integuments and periosteum (which was loosened from the carious bone by suppuration), has been made along the upper margin of the rib, and a flap turned downwards. The thickened pleura was then loosened with the handle of a scalpel from the posterior face of the rib, so as to allow, first, the insinuation of the finger between it and the rib; and, secondly, the introduction along the finger of one blade of a pair of cutting forceps, with which the first section of the rib is made.

- a. Left fore finger of the surgeon.
- b. Flap reverted from the face of the rib.
- c. Anterior margin of the bony part of the rib, which is seen roughened and carious.
- d. One blade of the forceps with which the division is made, inserted behind the rib. After this section, the fragment of the rib was raised and detached with the knife by a cut through its cartilage at the inner end of the wound.

(Fig. 2.) RESECTION OF THE UPPER HALF OF THE SCAPULA. (*Process of Janson.*)

This operation is called for only in cases of osteo-sarcoma, to which the upper half of the bone is exposed, in

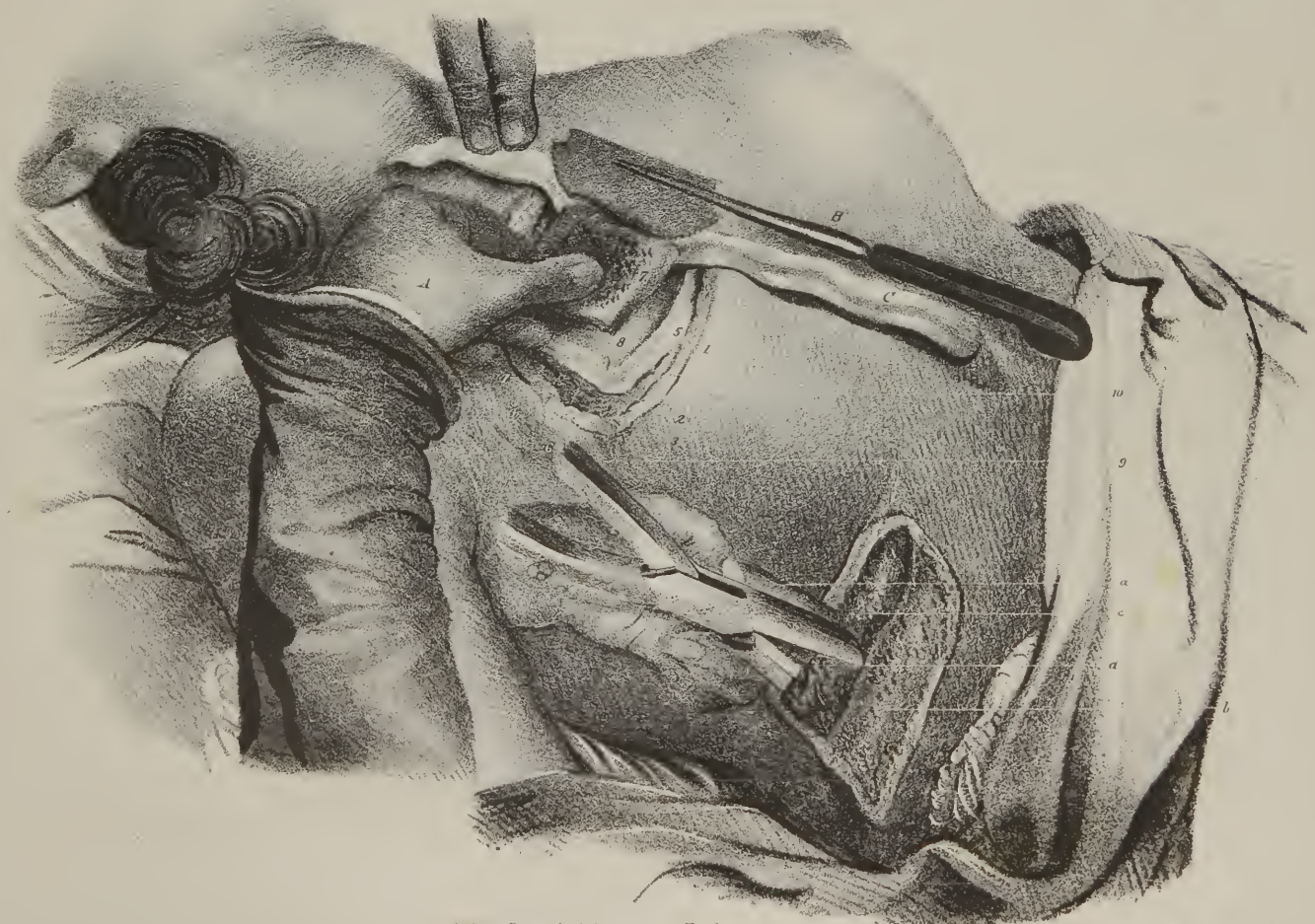
Fig. 2

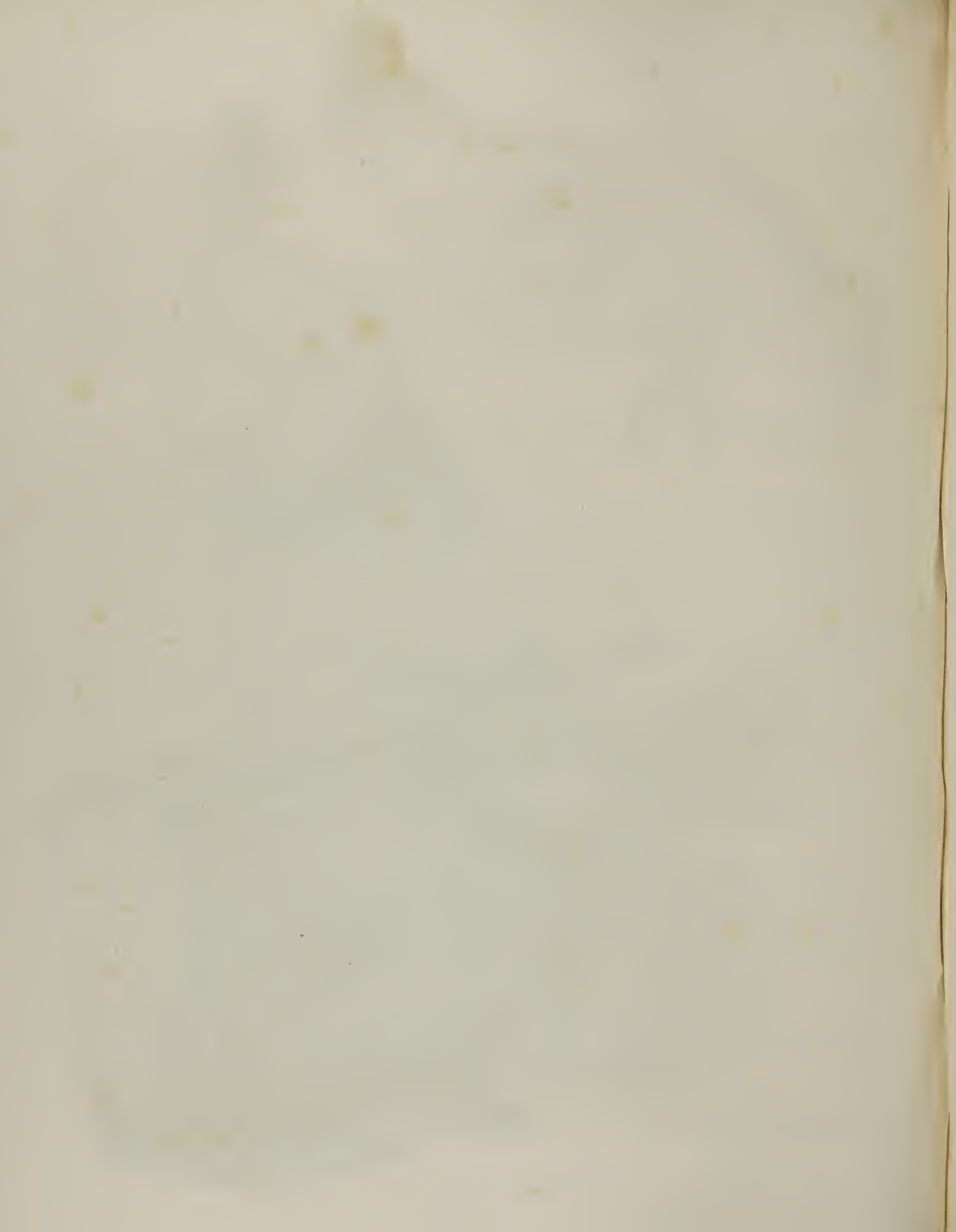


Fig. 3



Fig. 1





margin removed with the saw and forceps, as directed in resection of the chin. The base of the jaw, if superficially affected, might be exposed and resected in the same manner, leaving a rim of bone above to preserve the contour of the face, and serve as a basis for granulations.

PARTIAL RESECTION OF THE STERNUM. (PL. XXVII.)

Caries and necrosis resulting from scrofula, syphilis, abscess of the mediastinum, or external injuries, are the common causes which require the resection of this bone. When the affection is chronic, as is usually the case, the pleura becomes thick and resisting, and is pushed away from the bone by the purulent fluid which accumulates to more or less extent below it, so as to give space for the performance of the operation, without risk of injury to the pulmonary organs. I have on three occasions resected parts of this bone, the superficial position of which renders the operation by no means difficult. One of the cases permanently recovered; the other two patients, who were black, ultimately died of phthisis, a termination which those familiar with hospital practice must have frequently observed in this affection, where the operation has either not been attempted at all, or deferred too long. No fixed

plan of proceeding can be established for resection of the sternum; but resort may be had to some of the various methods common to resection of other bones. The soft parts, which will be found thickened, often lardaceous, and loosened from over the bone at different points, are to be opened by a T or crucial incision, and the angles dissected back. The trephine, Hey's saw, the cutting forceps, the gouge, and a pair of strong pliers, are the instruments which will be found most useful. The position of the pericardium behind the lower and middle portion of the bone, the pleura at the sides, and that of the internal mammary artery, must all be borne in mind by the surgeon. The dressing and after treatment should be so managed as to leave a free place of exit for the suppuratory discharge. After the cure it has in some instances, where the cicatrix was yielding, been found necessary for the patient to wear a plate of horn or leather as a measure of protection.

PARTIAL RESECTION OF THE RIBS. (PL. XXVII.)

Resection of the ribs and sternum were both practised by Galen. Richerand was the first to revive the operation on the former, which had fallen into desuetude. In 1818, he removed the middle parts

consequence of its superficial position. In the drawing, the operation is represented at the moment of its conclusion.

1. 1. Section of the integuments on the back of the shoulder.
2. Section of the upper part of the trapezius muscle.
3. Section of the levator scapulæ.
4. Section of the deltoid.
5. Section of the rhomboideus.
6. Section of the infra-spinatus muscle.
7. Section of the subscapularis.
8. Perpendicular cut through the acromion process.
9. Angular division of the body of the scapula below the spine—the glenoid cavity and the articulation of the shoulder joint being preserved.
10. Bottom of the wound occupied by the superior heads of the serratus major anticus muscle.
11. The tendon of the supra-spinatus muscle divided—the muscle itself being removed, with the portion of bone excised.
12. Ligature of the superior and posterior scapular arteries.

(Fig. 3.) RESECTION OF THE EXTERNAL HALF OF THE CLAVICLE.

The case is supposed to be one of caries of the acromial extremity of this bone. An operation somewhat analogous may be required in cancer of this bone, but in that case, if the tumour is large and irregular, the difficulty of resection will be singularly increased.

A crucial incision has been made, so that in the reflection of the flaps the acromial half of the clavicle is completely exposed. The clavicle, after having been isolated upon its sides, and a compress passed below it so as to protect the subjacent parts, has been divided near its middle with a chain saw. The stage of the operation shown, represents the proceeding of the surgeon after this section of the bone.

- 1, 1, 1. The four flaps of the skin, formed by the crucial incision.
2. Insertion of the trapezius muscle separated from the upper margin of the bone.
3. Separation of the deltoid from the lower margin of the bone.
4. Subclavius muscle.
5. Place at which the clavicle has been divided with the chain saw.
 - a. A band with which the operator raises with his left hand the outer fragment (*b*), while he isolates it from its connections with the bistoury (*c*), and finally detaches it by a cut through the acromio-clavicular articulation. If necessary, it would be perfectly easy to remove the outer end of the acromion by the same process.

of four ribs of the left side, affected with osteo-sarcoma. A portion of the pleura, which was thickened and fungous, was cut away with the scissors, so as to lay open the cavity of the chest, expose the pericardium, and render the action of the heart visible. The lung of the left side collapsed, on the entry of the air, producing momentary symptoms of suffocation. The opening in the pleura was closed by the surface of the pericardium becoming adherent to its margins, and the wound healed. The patient, however, died three months after, of a return of the cancerous disease. Jæger enumerates fourteen cases of excision of the ribs, of which eight were successful. The operation is not in itself difficult or dangerous, as the pleura is always found thickened and often loosened from the ribs, in consequence of the disease of the latter which renders the operation necessary.

Operation.—The patient must be placed on his side, back, or abdomen, according to the part on which the operation is to be practised. The first step is to uncover the diseased rib. In a case in which I resected during the winter of 1842–3, a carious portion of the ninth rib of the right side, two inches and a half long, I found the periosteum separated from the bone by an accumulation of pus, so that I could pass a director under it after I had divided the soft parts on a level with the upper surface of the bone. The incision was prolonged to the extent of three inches, and then on the side next the spine, turned at right angles so as to cross the rib from above downwards. The flap thus formed was turned off from the bone, the intercostal muscles and the fascia covering them divided carefully on the upper margin of the rib, and the thickened pleura separated from the latter, partly with the fore finger and partly with the handle of the scalpel insinuated flatwise. The finger could now be passed between the pleura and the bone, so as to make room for one blade of the large cutting forceps with which the section was made. The cartilaginous extremity of the rib was next divided with the knife, and the piece raised up and removed with a few touches of the edge on its inferior margin, in order to loosen it from its adhesion below without injury to the intercostal vessels. A Hey's or a Barton's saw, or a chain saw, may be used instead of the forceps to divide the bone, but in such cases it is necessary to pass a compress underneath, in order to protect the pleura. A crucial or T incision will in some cases be required to open the soft parts, or even two quadrilateral flaps, as in the process of Jæger, may be raised over the rib, and reversed in opposite directions. In one case Mr. McDowell, after dividing the rib towards its middle, disarticulated it from the vertebra, carefully avoiding any lesion of the spinal nerves. The wound is to be closed with adhesive straps, and covered with simple dressings; a roller should be passed round the chest.

Accidents.—Bleeding may occur from the intercostal artery; but there could be little difficulty in securing the vessel, even if it were necessary to dilate the wound posteriorly for the purpose. If the pleura should be perforated so as to admit air into its cavity, the wound must be immediately closed with a linen compress covered with cerate and overlaid by a mass of charpie.

Partial resection of the vertebra.—A part of one or more of the arches with the spinous processes of the vertebræ have been removed in cases where they have been fractured and depressed on the medulla, or where injury followed by an irregular growth

of callus, had produced symptoms of spinal irritation or paralysis. The prognosis in such cases is always doubtful, in consequence of the injury previously inflicted on the medulla, as well as from the inflammation of the theca that is liable to follow the operation. Jæger relates six instances in which it has been done, but in two only of these with any advantage. In four well-known cases, those of Cline, Tyrrel, Barton, and A. G. Smith, the operation did not eventuate successfully.

Operation.—The patient is to be placed on his belly. An incision from three to six inches long, according to the thickness of the muscles by the side of the spine and the number of vertebræ affected, is to be made over the tops of the spinous processes. This is to be crossed at each end by a transverse incision two to three inches long, which should divide the soft parts down to the bone. The flaps are then to be dissected off on either side from within outwards so as to expose the spinous and transverse processes, and held asunder with blunt hooks. The vertebral arch is next to be divided on each side with a Hey's saw, between the roots of the spinous and transverse processes, but near the latter, and the ligaments connected with the isolated piece cautiously severed with a knife. The flaps are then to be reunited by two sutures and some adhesive straps. Tyrrel and Barton applied the trephine upon the arch; but the surface is too unequal, even after the spinous process is cut off with a chain saw or cutting forceps, to allow that instrument to act with effect.

PARTIAL RESECTION OF THE PELVIC BONE.

The removal of small portions of these bones in cases of caries, exostosis, and, as is asserted, osteo-sarcoma, has been successfully accomplished. But when the bone was affected to a large extent, with the development of a tumour of considerable size on its inner face, death has been known to follow almost immediately the completion of the operation.

In 1818, Sir A. Cooper removed successfully, in a case of exostosis, a part of the descending ramus of the pubis, with a Machell's and a Hey's saw. Van Onsevoort, in an instance of anal fistula, kept up by caries of the os coccygis, resected the whole of this bone. Leauté removed, in another case of caries, the whole of the crest of the ilium with success. The seat and extent of the affections requiring such operations, vary so much, that no fixed rules can be given for their performance. The proceeding of the surgeon must be determined according to the rules already given for the treatment of affections in other parts. The removal of a carious portion of the crest of the ilium, may often be effected with advantage. An incision should be made along the edge of the crista, and the outer covering dissected off in the form of a flap from the surface of the bone. The abdominal muscles are to be detached along its top, (if not already loosened by the disease, as I have found them in one instance,) and drawn inwards by an assistant; carrying with them the peritoneum and the edge of the iliacus internus. With the Hey's saw and the cutting forceps, a V shaped or quadrangular piece may then be easily detached.

RESECTION OF THE CLAVICLE. (PL. XXVII. FIG. 3.)

Surgical anatomy.—Small and superficial as the clavicle is known to be, no bone in the body has more important surgical

relations. Below it, and nearly in contact with it, pass the subclavian artery, vein, and the brachial plexus of nerves; just above it is found the termination of the internal and external jugular veins; and on the left side, though somewhat deeply placed behind it, is found the thoracic duct. Many arterial branches are found on its upper and lower surface, which are often increased in size, when the clavicle has become so enlarged by disease as to make pressure on the subclavian vessels. Muscles of large size, as the sterno-mastoid, the pectoral, the trapezius and the deltoid,—all of which cover important parts,—have their attachments upon this bone. The surgeon, therefore, should have a precise knowledge of the position of these parts, and especially of those connected with its internal extremity, which cannot be disarticulated without more or less difficulty and danger; the least slip of the knife being liable to open a vein so as to allow the entry of air into the circulation, or give rise to hemorrhage that it would be difficult or impossible to stanch.

Partial resection—sternal extremity.—Davie and Wutzer have both performed this operation with success. The former, in a case where the sternal extremity was so much luxated or forced backwards in consequence of a curvature of the spine, as to press on the œsophagus and render deglutition almost impracticable. The latter, in a case of caries. Davie divided the integuments for three inches along the internal end of the clavicle, separated as far as possible its surrounding ligamentous connections, and divided the bone across with a Hey's saw, at the distance of an inch from the sternum, previously introducing beneath it a piece of thin sole leather, so as to protect the parts below from the action of the saw. The end of the bone still remained attached by the interclavicular ligament; this he was obliged to *break*, using for this purpose the handle of a scalpel as a lever.

In case the end of the bone be enlarged from disease, the simple incision of the integuments over the bone would not suffice to expose it. A square-shaped flap, with the base above, should be dissected and turned upwards; or a crucial incision may be made as directed by Velpeau for the acromial extremity. A chain saw carried round the clavicle by the aid of a silver stilet, would be very convenient for the division of the bone.

Scapular extremity.—In a case of necrosis of the external end of the bone, Velpeau made a crucial incision over the diseased portion, each branch of which was about four inches long. After the flaps were dissected back, and the acromio-clavicular ligaments, and some fibres of the deltoid and trapezius divided, he was able, by pressing a wooden splint into the articulation and using it as a lever, to raise the diseased bone, and thus detach it from the sound parts. In cases in which it could not be raised in this manner, he proposes to divide it from above downwards with a hand saw, a Hey's saw, or from below upwards with a chain saw passed previously round it.

Roux,* under analogous circumstances, made a longitudinal incision over the clavicle, isolated the parts surrounding the bone, which he divided with the English chain saw adroitly passed below the bone. He subsequently divided the acromio-clavicular ligaments, and removed the piece, which was an inch and a half long.

Resection of the clavicle entire.—Cumming, in a case of gunshot

wound, extirpated, after disarticulation of the arm, not only the clavicle, but the whole scapula with it, and the patient recovered. Meyer removed, in 1823, the whole clavicle for caries, and in seven weeks afterwards the wound healed. The periosteum, which was in this case detached from the bone, and allowed to remain, formed a new ossific deposit; and at the time of the patient's death, which occurred five years afterwards, a thin bone was found to have been formed sufficient to support the movements of the arm, three inches and three-quarters long, united to a fibro-cartilaginous ligament, extending from the sternum to the acromion.

Professor Mott removed the clavicle of the left side nearly entire, in 1827, for an osteo-sarcomatous affection, which had enlarged the bone nearly to the size of the double fist, and occupied the greater part of the space between the top of the shoulder, the os hyoides and the angle of the jaw. This surgeon circumscribed the diseased mass by two incisions, one of which was convex below, and extended from the sternum to the acromion, and the other convex above, running from the acromion round the upper part of the tumour, as far as the external jugular vein. Along the line of the last incision, he divided the platysma myoides and a portion of the trapezius muscle; he next insinuated a director under the bone near the acromion, along the groove of which he passed a chain saw and divided the bone between the acromion and the coracoid processes. He now united the sternal extremities of the first two incisions; divided the external jugular vein between two ligatures; cut across the external portion of the sternocleido-mastoid, two inches above its insertion, and turned the lower section over the sternum; next pushed upwards and backwards the omo-hyoid, below which was found the internal jugular, which was also tied and divided. The diseased mass was then separated from the subclavian vein and thoracic duct with the handle of a scalpel. The pectoral muscle, the costo-clavicular ligament, and the subclavius muscle, were detached in succession from the lower surface of the tumour, and the bone finally removed by disarticulating it at the sternum. The operation was long and difficult, and more than forty ligatures were applied upon the divided vessels. The wound healed in the course of a month and a half, and the patient, by the aid of an appropriate apparatus, preserved to a considerable extent the movements of the shoulder.

PARTIAL RESECTION OF THE SCAPULA. (PL. XXVII. FIG. 2.)

Portions of the scapula have frequently been resected in instances of comminuted fracture of that bone. Larrey, Hunt, and others, have removed in this manner the acromion, the coracoid process, and even the neck of the bone; opening the soft parts for the purpose by a process similar to that for excision of the head of the os humeri. Portions of the bone have also been removed in cases of caries, tumours, and other chronic affections. Jæger and Champion removed the spine; Sommeiller the inferior angle of the bone; and Janson nearly the whole of the body, in a case of degenerated tumour.

Process of Janson.—The tumour in the case operated on by this surgeon was large, occupied the subscapular fossa, and weighed nearly eight pounds when removed. He circumscribed it by two semi-elliptical incisions nine inches in length, saving the integu-

* Thèse, par M. Hurtleaux. Paris, 1834.

ments as much as possible by dissecting them off from the lips of the incisions so as to lay bare the base of the tumour. He next divided the attachments of the trapezius, supra and infra-spinatus muscles, and discovering that the scapula above the spine was healthy, he divided the bone below the spine with the saw, thus leaving uninjured the articulation of the arm. The tumour was then loosened and removed. The wound left was six inches broad and nine inches long.

RESECTION OF THE SHOULDER JOINT. (PL. XXVIII).*

Comminuted fractures of the upper end of the bone with wound of the integuments, complicated luxations, caries, necrosis, and the various incurable organic affections, form the cases in which resection of this articulation may be practised with advantage, and for which there is no other alternative than that which was its substitute in former times—amputation of the arm at the shoulder joint. In none of the joints is resection more frequently called for, and in no one has it been attended with more beautiful

* The surgical anatomy of this region will be described under the head of amputation at the joint.

results, the upper extremity being preserved nearly entire, and in some few instances a new articulation reproduced. In the cases where the end of the bone has remained suspended after the cure in the midst of the muscles, without having formed a new connection with the scapula, the former usefulness of the limb has been in a great measure recovered by the wearing of an appropriate apparatus for sustaining its motion at the shoulder. Several instances, however, have been reported, even where no direct connection with the scapula was found, in which such an apparatus was not needed.*

General observations.—All the various processes devised for this operation may be arranged in two classes.

1. Those in which a mere incision of the soft parts is made.
2. Those in which a flap is raised up.

White, whose process has been adopted by *Larrey*, *Guthrie*, and others, directed a simple longitudinal incision to be made down to the bone, from the point of the acromion, for four or five inches towards the insertion of the deltoid, so as to divide this muscle in half. The lips of the wound being then held asunder by an assistant, the articulation comes into view. The capsule

* Syme, Moreau, Chaussier.

PLATE XXVIII.—RESECTION OF THE SHOULDER JOINT.

Fig. 1. (Process of Syme.)—The patient is supposed to be placed in the sitting posture; and the wound is represented as it appears at the end of the operation. An assistant compresses with his middle finger (*a*) the subclavian artery, and with the fingers of the other hand (*b*) keeps the flap, which is covered with a piece of linen, drawn upwards.

c. Lines of section through the deltoid.

d. Divided tendons of the supra and infra-spinatus and teres minor muscles.

e. Division of the tendon of the subscapularis; above which is also seen a section made through a part of the pectoralis major.

f. Bottom of the wound, formed by the glenoid cavity and the posterior surface of the capsule.

g. Section through the body of the os humeri near the termination of its surgical neck.

Fig. 2.—Adjustment of the flap, after the operation of Syme, by several points of the twisted suture. The prominence of the end of the acromion, and the depression immediately below it, are caused by the removal of the head of the bone.

(*Fig. 3.*) (*Left side.*) RESECTION OF THE HEAD OF THE HUMERUS. (*Process of Bourguery.*)

The patient is placed in the sitting posture, and the arm raised by the left hand (*h*) of the surgeon. One assistant makes pressure with the thumb (*i*) on the artery above the clavicle, and another should hold the two ends of the compress (*j*), which has been passed below the bone, so as to draw the soft parts away from the joint, and at the same time sustain the patient. A third assistant should stand in front so as to raise with his left hand by the band (*k*) the bridge of muscle and integument (*m*) in front of the bone, while with his right hand he manages one handle (*l*) of the chain saw, so as to act in concert with the surgeon, who moves the other end of the saw. The bridge of muscle has been raised, and the bone isolated, as described in the text. The drawing represents the act of dividing the bone.

Fig. 4.—Appearance of the wound after resection by the process of Bourguery. By this process the articular surface of the scapula may also be removed if found carious.

q. Long head of the triceps extensor muscle.

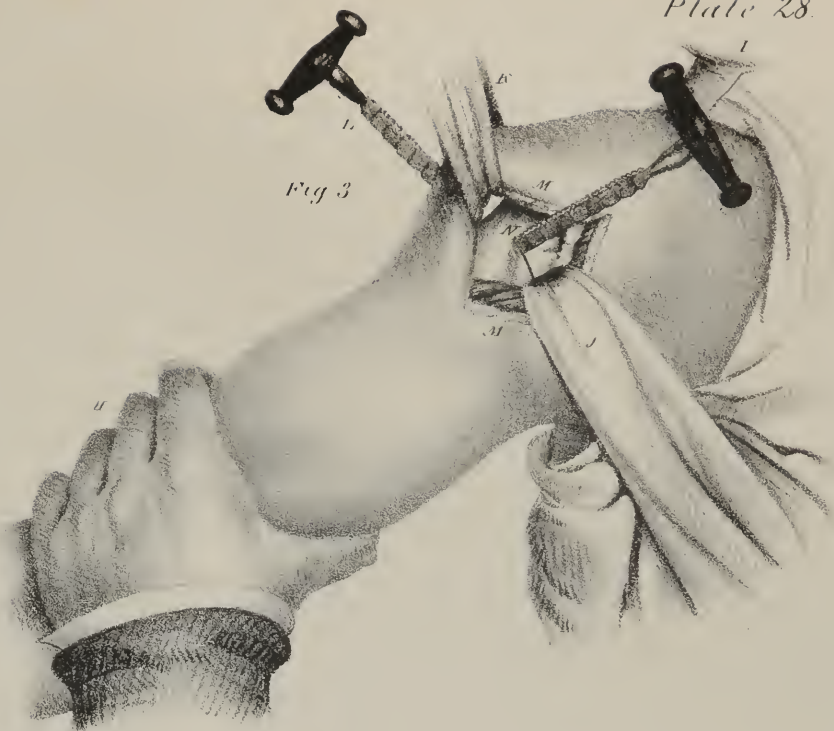
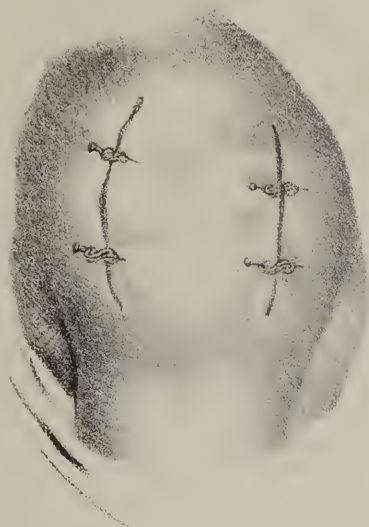
r. Biceps and coraco-brachialis muscles.

s. Divided tendons of the supra and infra-spinatus and teres minor muscles.

t. Divided tendon of the subscapularis muscle.

u. Division of the os humeri.

Fig. 5.—Closure of the wound, after the same operation, by four points of the twisted suture.



Why?



Fig 1

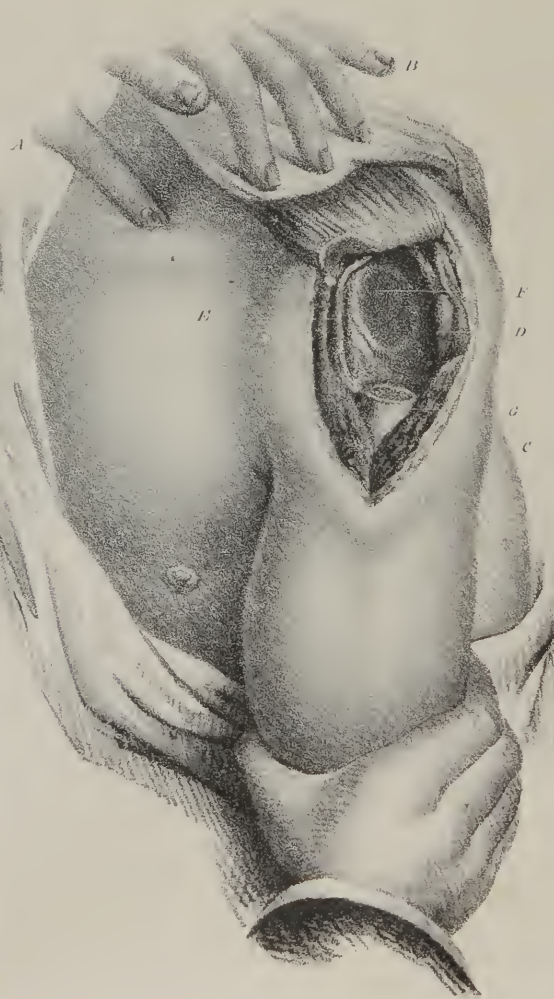
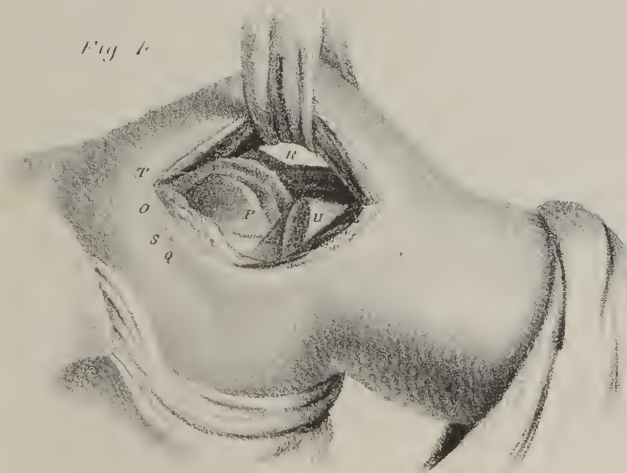


Fig 4.



is to be opened transversely, and the insertions of the four articular muscles carefully cut with a probe or button-pointed bistoury, rolling the bone so as to bring them successively under the action of the knife. The long tendon of the biceps may usually be saved, though its division if necessary may be made without much disadvantage. The elbow is then to be forced inwards and upwards, in order to luxate the head of the humerus and make it protrude at the wound, and the knife carried behind the head so as to separate the soft parts on its inner face. A compress or a piece of card or wood is to be passed between the humerus and soft parts, and the diseased portion cut off with a saw. This process is the most simple and the most ancient, but at the same time one of the most difficult, except in cases where the joint has been previously opened, or the head separated from the body of the bone as in a gunshot wound.

To facilitate the division of the tendons, and the protrusion of the head,—the most difficult step of the operation,—*M. Baudens* has proposed to divide the deltoid across, at each angle of the vertical cut, *below* the skin and without cutting the latter.

Textor modified this process so as to give to the external wound the shape of the letter L, or that of a \perp , the longitudinal incision passing down on the outer side of the biceps, and the transverse across the deltoid.

Bromfield crossed the lower end of the longitudinal incision of White, with a transverse incision through the deltoid, forming a \perp reversed.

Bent made a short transverse incision over the acromion at the top of the longitudinal, \perp ; this, when the triangular flaps are dissected off, exposes largely the joint, and serves particularly well when it is necessary to remove in addition a part of the acromion process or cervix scapula.

The process of *Sabatier* as modified by *Goyraud* consists in raising up and turning over the acromion, a V shaped flap of the deltoid from the anterior and superior part of the shoulder.

Moreau and *Manne* formed a quadrilateral flap by means of two vertical incisions; one passing down from the acromion and the other from the coracoid process. These were united by *Moreau* by a transverse cut immediately below the acromion; by *Manne* at their lower extremities. *Bell* and *Morell* formed a semilunar flap with the base upwards.

Buzaires adds to the longitudinal incision of White, in cases where this does not yield room enough to effect the extraction of the head of the bone, a transverse cut made from the acromion either along the spine of the scapula or in the direction of the clavicle; or in both directions, if it be necessary at the same time to resect a portion of the scapula.

Malgaigne proposes to modify the longitudinal incision of White, by commencing higher up and a little more to the inner side: *viz.*, at the top of the coraco-clavicular triangle. He extends the incision downwards for five inches, dividing at one stroke the skin, the deltoid, and the capsule. This exposes the joint freely on its inner and upper surface, and gives great facility in the extraction of the head.

Roberts commences the longitudinal incision from the anterior margin of the clavicle, two fingers' breadth from the acromio-clavicular articulation, and carries it down through the deltoid between the coracoid and acromion processes.

Syme (Pl. XXVIII. fig. 1), adds to the longitudinal incision of White, another which passes from its inferior termination backwards and a little upwards, so as to divide transversely the external part of the muscle. The raising of this quadrilateral flap exposes well the structure of the joint. The capsule is to be divided across, the finger introduced into the joint to serve as a guide to the knife in the section of the articular tendons, and the operation completed as has already been described. The only artery requiring to be tied is the posterior circumflex.

Process of Bourguery. (Pl. XXVIII. figs. 3, 4, and 5.)—The patient is to be seated upon a chair, with his head held over to the opposite side by an assistant, who at the same time with one hand compresses the subclavian artery over the first rib.

1st Step.—The surgeon, standing on the outside, grasps the arm (which is to be slightly drawn out from the trunk), with the left hand, and enters a catling at the back part of the articulation an inch and a half above the posterior fold of the armpit. Circumscribing the bone and the capsule with the point, the knife is to be next passed out below the acromion, as in *Lisfranc's* operation for disarticulation at the shoulder joint. The knife is now to be carried down close on the outer face of the bone, towards the insertion of the deltoid, so as to form two vertical incisions each three inches long—the upper terminations of which are found at the places of the entry and exit of the point of the knife already mentioned. The knife is then to be withdrawn; a compress is to be passed through the wound for the purpose of raising the bridge formed between the incisions, which will consist of the greater part of the mass of the deltoid.

2d Step.—An assistant raises the arm in order to relax the muscle, and at the same time lifts the bridge; the surgeon then with a common scalpel separates the attachment of the biceps round the neck of the humerus, so as to be able with the aid of a spatula to pass a compress below it, the two ends of which are to be drawn downwards and backwards, in order to carry out of the way of the instrument the muscles, vessels, and nerves that occupy the armpit. The capsule and the tendons of the articular muscles are now to be cut across; a chain saw is next to be carried round the neck of the bone, so as to divide it from within outwards. The loosened fragment is then removed by dividing the attachments of the capsule on its posterior face, and luxating it through the anterior incision. The glenoid cavity and the adjoining parts of the scapula are next to be examined, and any part found diseased should be removed with the saw or cutting forceps. If, on sounding with the probe, the neck of the scapula appear much involved in the affection, or if extensive fistulous sinuses have formed, amputation at the joint will be preferable to resection.

Dressing.—Whatever process is adopted, the incisions are to be closed by the interrupted suture, after the introduction of a mesh at the depending point of the wound for the purpose of affording exit to the purulent discharges. The divided osseous surfaces are to be brought gently together, and the arm kept perfectly at rest in the apparatus for fractured clavicle.

Appreciation.—Of the various processes above described, those with longitudinal incisions merely, are to be preferred, whenever the state of the bone or the soft parts admits of their application. These inflict less injury on the deltoid muscle; this is a matter of some importance, as one of the consequences to be dreaded, where

a flap has been formed by a transverse section of its fibres, is such a retraction of the ends as will prevent their coming together and rendering the muscle again capable of acting on the arm. Of the longitudinal incisions, I prefer those of Bourcary and Malgaigne; of the flap operations, those of Syme and Bent. But they may all occasionally be found applicable—the greater or less size of the head of the bone, or the peculiar injury of the soft

parts, often rendering some one more particularly indicated than the rest.

RESECTION OF THE ELBOW JOINT. (PL. XXIX.)

The elbow joint, next to that of the shoulder, is considered as offering the most favourable indications for resection; for even in

PLATE XXIX.—RESECTION OF THE ELBOW JOINT.

(Fig. 1.) RESECTION OF THE LOWER END OF THE HUMERUS. (*Process of Moreau.*)

The patient is laid upon the abdomen, and the left arm, carried a little outwards from the trunk by an assistant, presents its posterior surface upwards. With his other hand, the assistant may compress the trunk of the brachial artery. The drawing represents the state of the wound at the end of the operation, when a few fibrous attachments alone remain to be cut. The portion represented as removed is far greater than will be required, unless the whole head of the bone should be found carious.

- a. Flap, formed of the integument and the inferior end of the triceps muscle, dissected from the bone and turned upwards towards the shoulder.
- b. Upper border of the wound, formed by the cut through the triceps.
- c. Inferior border of the wound, formed by the supinator radii longus and the radial extensors.
- d. Bottom of the wound after the resection of the bone, formed by the posterior surface of the brachialis anticus, the fibres of which have been cut obliquely at their attachment to the bone. The white line indicates the position of the ulnar nerve.
- e. Section of the os humeri.
- f. Olecranon process of the ulna; below this is seen the articular cavity on the end of the radius. The ends of these bones are supposed to be healthy, so as not to require removal.
- g. Left hand of the operator holding the resected piece, while with the other hand he detaches it with the bistoury (h).

(Fig. 2.) RESECTION OF THE ENTIRE JOINT, AS EMPLOYED SUCCESSFULLY BY THE AUTHOR.

The patient is represented as lying on the abdomen, and the right arm resting over the side of the bed, with its back uppermost. Two longitudinal incisions have been made, as shown in fig. 3, and one transverse, uniting the former over the back of the joint, the cavity of which it opens; the two quadrangular flaps (a, b) have been dissected up from the bone and reverted. The end of the olecranon process was first removed, then the condyles of the humerus, and lastly, the heads of the two bones of the forearm.

- c. Ulnar nerve winding round the inner condyle to get to the forearm.
- d. The articular head of the radius.
- e. Upper extremity of the ulna. The olecranon process has been detached at its base with the ordinary amputating saw, the arm being held partly flexed for the purpose. The black line indicates the place where the head of the ulna was notched with the saw.
- f, g. Outer and inner condyles of the os humeri.
- h. Lower end of the os humeri covered with new bony deposits, but not carious or otherwise diseased so as to require extirpation. Two sections have been made with a short straight saw from either tuberosity of the bone, meeting at an angle in the sigmoid fossa.
- i. A stout pair of bone forceps, with which the diseased articular surface was removed, partly by splitting and partly by cutting, from the shaft. One blade is entered in the sigmoid fossa, and the other on the inner face of the inner condyle. The instrument was subsequently applied in the same manner on the opposite margin of this bone.
- k. Small wedge-shaped chisel, by which with a few taps of the mallet, the section of the head of the ulna was completed.

Fig. 3. Closure of the H shaped wound after the operation, with several hare-lip sutures as shown in this figure. The interrupted suture is more readily applied when the parts are thickened and hard, and answers the purpose equally as well.

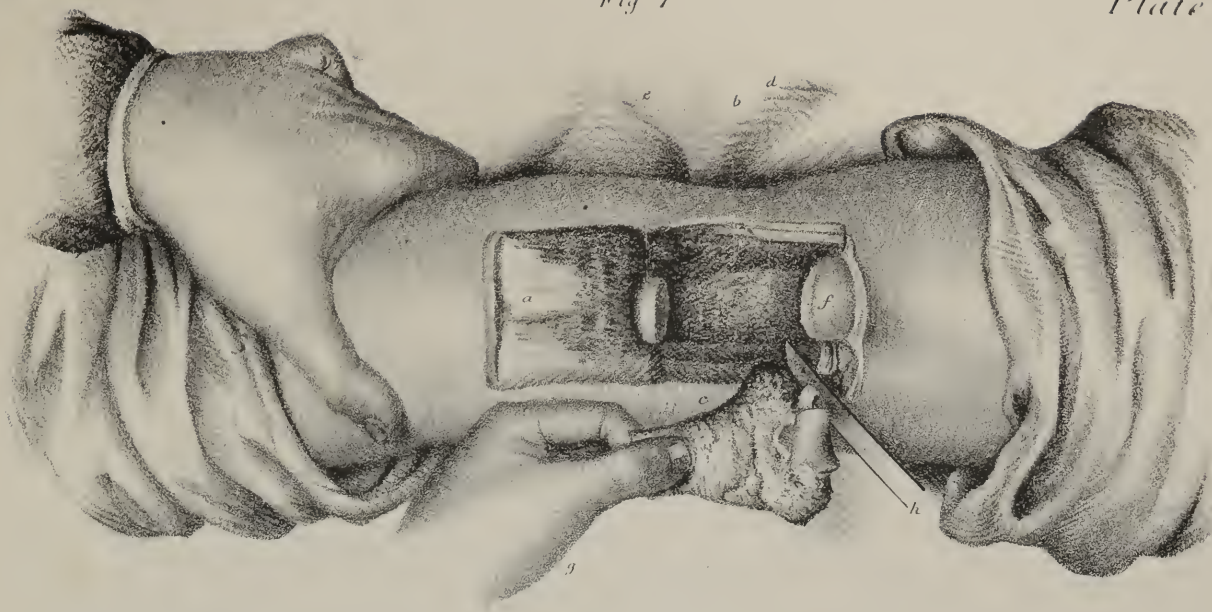


Fig 3

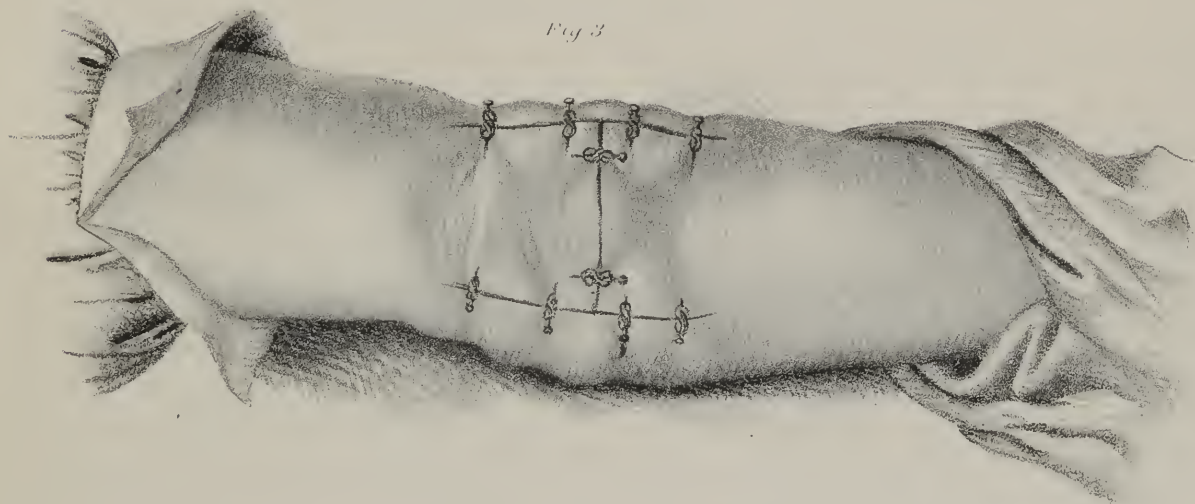
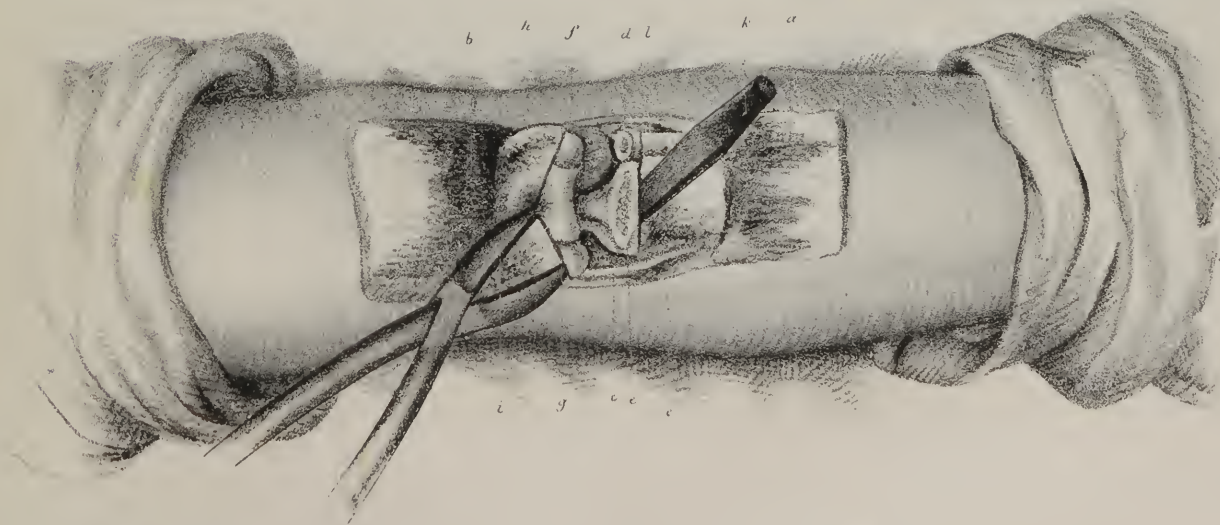
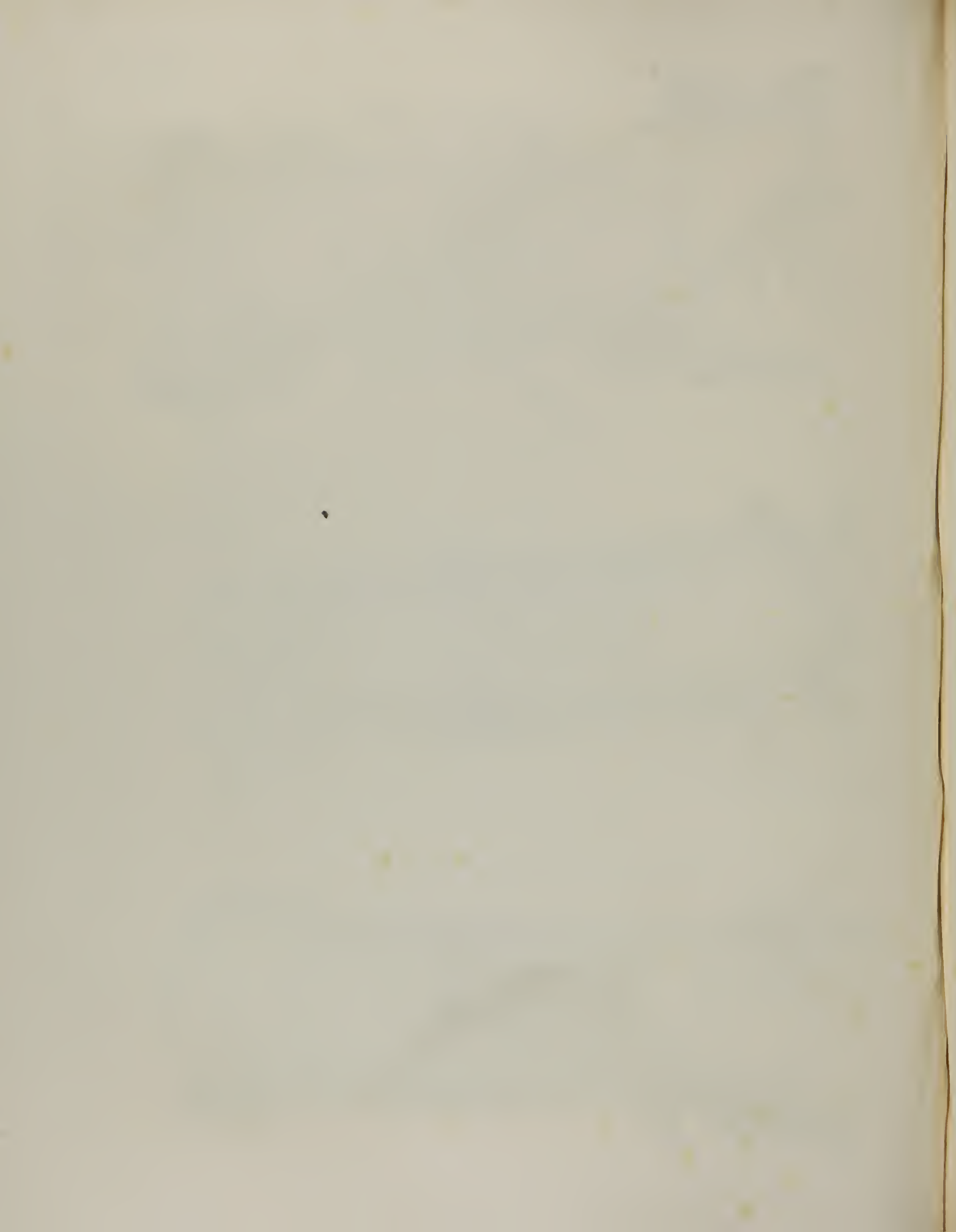


Fig 2

b h f' d l k a

i g e e e





case ankylosis should succeed to the operation, the patient will still retain in a good degree the uses of the hand and limb. It was first practised by Moreau, (in 1728,) and since that time has been done by a number of surgeons, for caries, gunshot wounds, and comminuted fractures complicated with opening of the joint. Velpeau has collected sixty cases, in forty of which the operation was successfully performed.

In a majority of instances, the condyles of the humerus will be found the part most extensively affected. The necessity of resecting the condyles merely, or of extending the operation at the same time to the olecranon and the head of the radius, will depend upon the degree of pathological alteration in the joint.

The brachial artery, and the median and radial nerves lying on the front of the arm, separated from the bone by the brachialis anticus muscle, are not liable to be injured; but the ulnar nerve is much endangered on account of its position, and must, when it is necessary to take away a large portion of bone, be carefully detached from the fibrous sheath between the olecranon and the adjacent tuberosity of the humerus in which it is contained. But in cases where the articular facets of the humerus only require to be removed, I have not found it necessary to disturb the nerve from its bed. The thickness of the muscles and the position of the vessels on the front part of the limb, render it necessary to attack the articulation from behind.

Various processes have been employed by different surgeons in resection of these bones.

Longitudinal incision.—Park made a longitudinal incision four inches long over the back part of the elbow joint, separated the soft parts from the bone, divided the lateral ligaments, sawed off the olecranon process, dislocated the humerus backwards, and subsequently divided the bones. This process is attended with difficulty, from the little space it allows even when a transverse incision is made in addition over the olecranon, and has, therefore, been abandoned.

Simpson improved this method by crossing the ends of the longitudinal incision by two transverse ones \perp , so as to form two lateral flaps. The objection to this, is the increased risk of injury to the ulnar nerve.

Incision in \perp . Jäger, assuring himself of the position of the ulnar nerve by pressure with the finger, makes an incision directly over it two inches and a half long, the centre of which rests on the internal condyle. The ulnar nerve is then to be separated from its sheath, and drawn by an assistant with a blunt hook over the internal condyle. The operator, strongly flexing the forearm so as to render the tendon of the triceps tense, next enters a strong bistoury at the back part of the joint, and opens it transversely by one cut, which divides the tendon of the triceps, the skin, and the posterior part of the capsule—turning subsequently the edge of the knife inwards and outwards so as to divide the lateral ligaments. The two flaps thus formed are to be dissected up, and the joint resected in whole or part, according to the extent of the pathological alteration. Roux and Liston employ this form of incision. Roux makes, however, the longitudinal incision over the external condyle, and dissects off the two triangular flaps towards the internal condyle, so as to expose the inner and posterior face of the joint. In cases where the resection is only to extend to the articular facets of the humerus, the reflection of the

flaps inwards enables the surgeon to accomplish his object without disturbance of the ulnar nerve. This is a neat process, and leaves a wound which cicatrizes readily after the operation; but under many circumstances,—as where the bones are much enlarged, and the subcutaneous tissues are thickened and hardened,—does not sufficiently expose the joint to render the operation easy.

Semilunar incision.—Sedillot has proposed, in cases where we wish to remove only the inferior extremity of the humerus, to make a semilunar incision convex downwards, which should cross the point of the olecranon. The arm remaining flexed at a right angle, the tendon of the triceps is to be cut, and the flap reflected upwards, the lateral ligaments divided, the ulnar nerve separated from the olecranon, and the end of the humerus luxated backwards, so as to be divided with the saw. If all the bones of the joint require to be removed, he advises two lateral semilunar incisions, the arches of which should meet on the centre of the olecranon, and the extremities rest upon the condyles of the humerus. After dividing the ligaments, opening the joint, and sawing off the olecranon, he proceeds to the resection of the end of the humerus.

These processes of Sedillot I find easy of execution on the dead body; they might answer well in cases of traumatic injuries of the joint, but they have no particular advantages over the incision in \perp , and are liable to the same objections.

Incision in \perp .—The process of Moreau and Syme, which consists of two longitudinal incisions, united by one drawn transversely over the joint, has been generally adopted, as the most easy of execution, and fulfilling best the indications, whether the end of the humerus is to be removed alone, or in conjunction with those of the two bones of the forearm. The greater dimension of the wound occasioned by this process, is of little importance compared with the greater facility it affords for protecting the surrounding parts, for determining the extent of the disease, and finishing more speedily the operation.

The author employed this process (Pl. XXIX. fig. 2), in the following manner, in a case of fungus of the joint with caries of the articular surface of the three bones forming its structure, for which, from the constitutional irritation the patient had suffered, and the repeated formation of phlegmonous abscess above the joint, it had been proposed to amputate at the arm. As this operation has but in a few instances been practised in this country, the details will be given somewhat at length.

I was assisted in the operation by Drs. Peace, Davis, Huston, and others. The patient was placed with his face downwards on a bed, over the side of which his arm was extended and supported by an assistant. Another assistant steadied the shoulder, and restrained the movements of the patient. A bistoury was now entered perpendicularly into the joint, on a level with the top of the olecranon, with its back almost in contact with the ulnar nerve, as directed by Syme, and the integuments, triceps tendon, and capsule, divided with a sawing motion completely across to the external tuberosity of the arm. From either end of this transverse incision, the integuments were divided through to the bone, upwards as well as downwards for an inch and a half along the opposite margins of the arm, so as to give the wound the shape of the letter H, and form the two square longitudinal flaps of

Moreau. The ascending incision, on the ulnar side of the arm, was inclined at its *commencement* a little towards the radius, for the purpose of more surely avoiding the course of the ulnar nerve. The flaps were dissected from the surface of the bone, and reflected upwards. The upper one was so loosened by suppuration from the end of the humerus, as to be readily stripped off. Its reflection upwards was more difficult in consequence of the great effusion of ossific matter in the cellular tissue on the side next the bone. The olecranon process was then sawed off at its base, in a direction slightly sloping towards the joint. The surfaces of the bones forming the joint were now well exposed to view; the ends of the humerus and ulna were found extensively affected with caries, and the synovial membrane of the interior of the joint, as

well as that of the lesser sigmoid cavity, was soft and pulpy. The caries had not, however, extended beyond the articular epiphysis of the bone, though each bone at a considerable distance from the joint was thickened, and rough, and reddened by granulations in the process of formation. The ligamentous structures on the sides of the articulation were now cut through with the knife; care being taken in dividing the internal lateral ligament to loosen previously the ulnar nerve from its bed, and press it inwards with the left thumb, while the bistoury was introduced between it and the ligament with which it lies in contact.

The arm was then bent and the radius twisted forward, so as to expose completely the external condyle. This was divided with a Barton's saw from a point just below the tuberosity nearly into

PLATE XXX.—RESECTION OF THE BONES OF THE FOREARM.

(Fig. 1.) RESECTION OR EXTIRPATION OF THE METACARPAL BONE OF THE THUMB.

A quadrilateral flap has been raised from the radial side of the bone and reflected on the back of the hand. The bone (*a*) has been denuded on its dorsal surface, and disarticulated from the first phalanx with the knife. It is represented as held by the left hand of the operator, at the moment at which he is about to sever its last ligamentous connections at the carpal joint with the bistoury (*b*). At the palmar margin of the wound, is seen the muscles belonging to the ball of the thumb, and at the dorsal, the extensor tendons, which have been carefully separated from the bone.

(Fig. 2.) RESECTION OF THE CARPAL EXTREMITY OF THE RADIUS.

A longitudinal incision has been made along the outer margin of the radius, the lower end of which is crossed by another at a right angle, so as to form a sort of Γ incision. The flaps have been dissected up, the bone isolated so as to admit of a compress being passed below it; and over this passed a chain saw, with which the bone has been divided. The operator then raises the fragment, as shown in the drawing, after having opened the radial articulation, and completes the resection by dividing the remains of the ligamentous connection on the inner side of the bone with the knife (*c*). A hook draws outwards the aponeurosis, the cephalic vein of the thumb, the radial nerves and vessels, and the extensor tendons of the thumb as well as those of the two carpal radial extensors. On the inner or dorsal side of the wound are seen the extensor tendons of the fingers. At the bottom of the wound are seen the fibres of the pronator quadratus muscle.

(Fig. 3.) RESECTION OF THE CARPAL EXTREMITY OF THE RADIUS.

A longitudinal incision has been made as in the process of Roux, from the lower end of which a short incision was made in the direction of the head of the radius. The flap has been reverted, the bone isolated, and a band passed below, with which the soft parts are partly drawn away from the bone. Over the band a chain saw has been passed, with which the bone is about to be divided. *c, d*, are the tendons of the extensor and flexor carpi ulnaris muscles.

(Fig. 4.) RESECTION OF THE RADIO-CARPAL ARTICULATION ENTIRE. (*Process of Bourguery.*)

The soft parts are separated entire in two masses, anterior and posterior, so that the different tissues, vessels, nerves and tendons, are undisturbed in their relations with each other. The sheaths of the tendons that glide over the bones are necessarily opened. By this process, the carpal extremity of the radius and ulna alone, or the whole articulation may be removed, according to circumstances.

A longitudinal incision has been made on either side of the joint, and the soft parts carefully separated from the anterior and posterior surfaces of the bones, so as to admit of the introduction of two linen bands, by which they have been lifted from the bone; this has given room for the action of the chain saw with which the lower ends of the radius and ulna have been divided. The same process as shown in the drawing, is repeated in the section with the saw of the first range of carpal bones, in order to remove the joint entire.

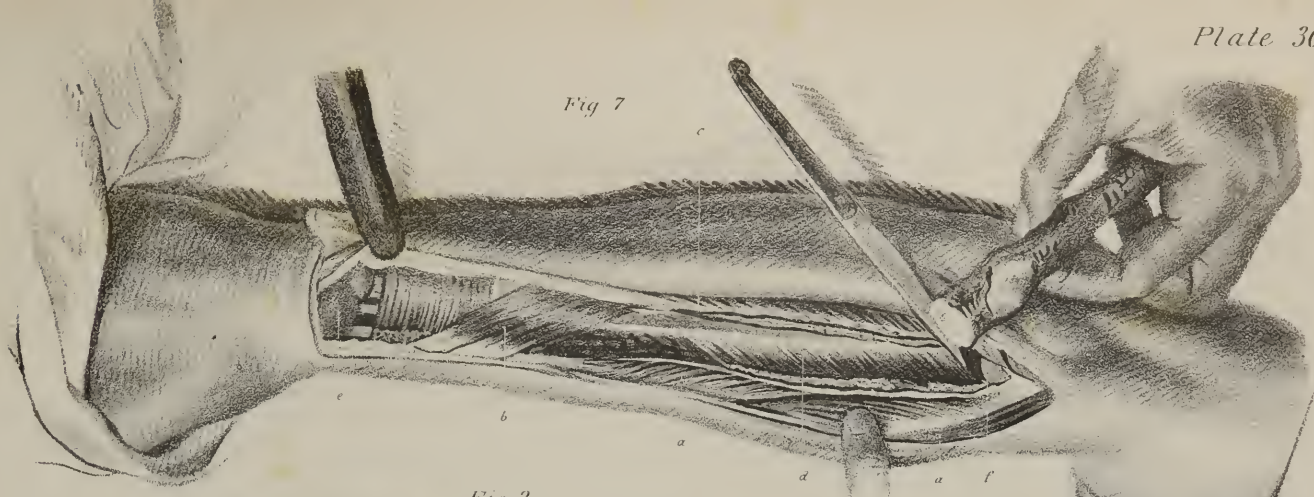


Fig 7

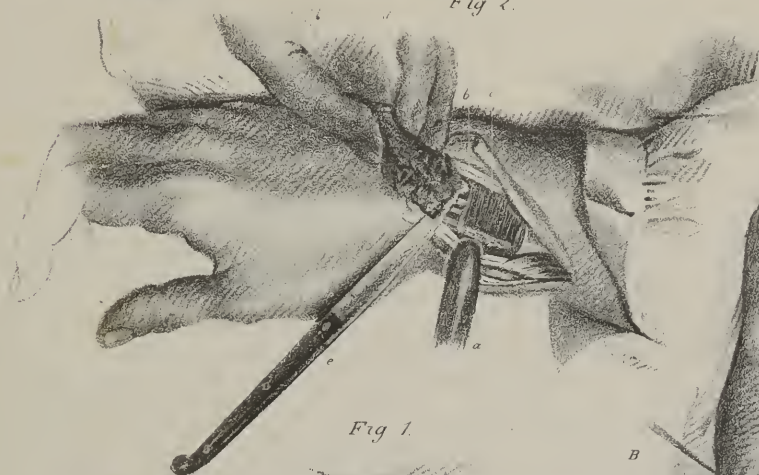


Fig 2

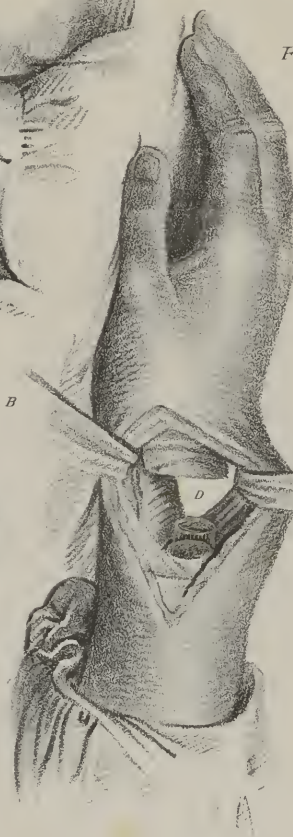


Fig 5

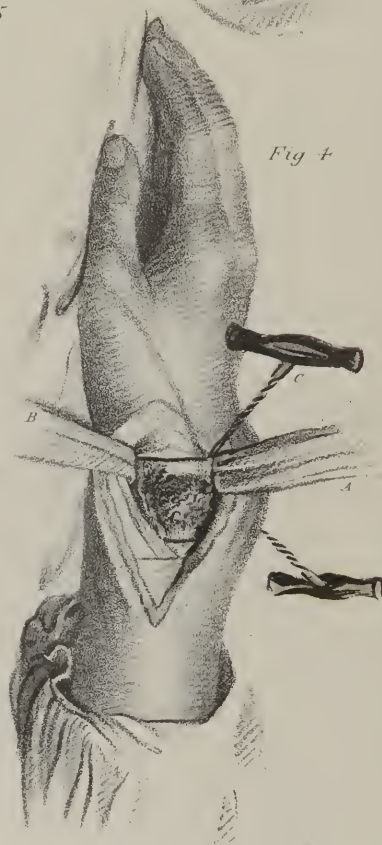


Fig 4

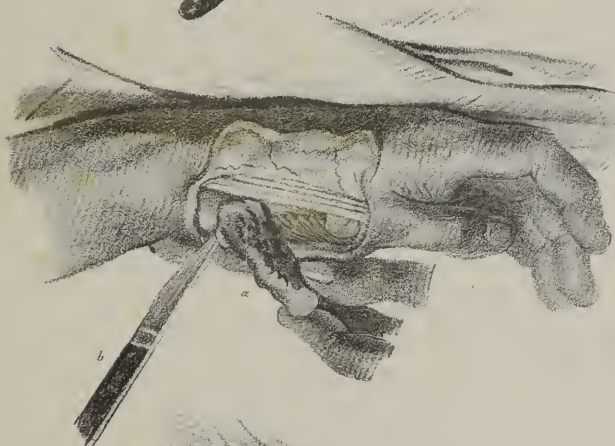


Fig 1

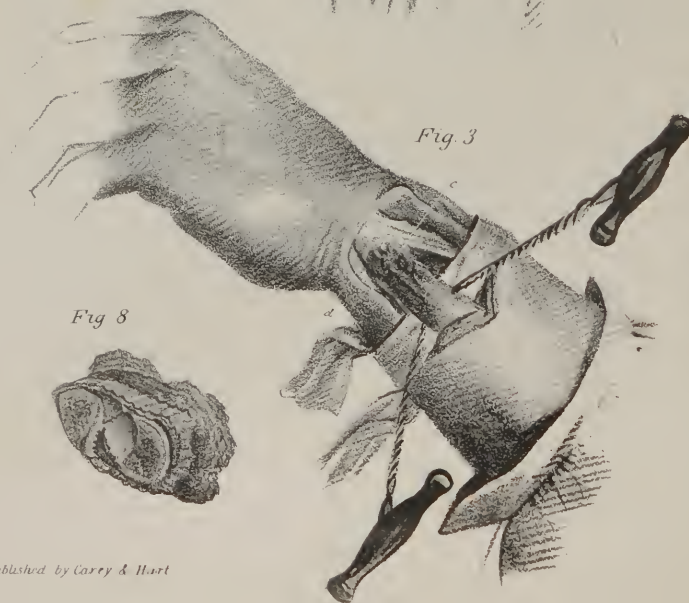
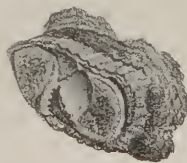


Fig 3

Fig 8



the sigmoid fossa. The internal condyle was sawed in a similar manner, the forearm being twisted in the opposite direction, and the ulnar nerve pressed off with the thumb. The division of the bone was then completed with a pair of strong cutting pliers, partly by splitting and partly by cutting. Subsequent experience has, however, convinced me that a thin wedge-shaped chisel, forced into the groove of the saw with the tap of a mallet, answers under such circumstances nearly as well as the cutting forceps. The articular face of the bone thus separated from the shaft through the sigmoid fossa, was twisted off with a large pair of curved tooth forceps, and detached with the point of the knife. The ulna was now made to project backwards, and the soft parts separated from it on either side with the bistoury, for the space of three-quarters of an inch; the knife being carried on with the edge in contact with the inner side of the bone, so as to avoid the nerve which runs parallel with its sloping surface. The carious head of the ulna, which was soft and filled with fatty matter, was then detached with the saw and chisel, and its whole articular face with the point of the coronoid process twisted away with the forceps. The base of the coronoid process was not removed, as this was covered with the insertion of the brachialis anticus, and forms no part of the joint. The head of the radius, on which the cartilage was softened, was pushed up so as to project from the orbicular ligament, and snipped off with the cutting pliers. All the pulpy portions of synovial membrane, including that of the two sigmoid fossæ, were removed.

The forearm was now placed in a middle position between pronation and supination; but to do this it was necessary to divide the orbicular ligament of the radius, which resisted the movement. The cavity of the wound was sponged clean of blood, two small arteries were tied, and the flaps closed with six sutures passed merely through the integuments. The elbow was but slightly bent, in order to favour for the first five days union by first intention in the divided integuments. Simple dressings were applied, and a patent felt elbow splint well padded secured round the

joint with a figure of 8 bandage. The arm in addition was fastened to a pillow, and rested upon an inclined plane. About eight ounces of blood were lost during the operation.

The patient was placed under the free use of a solution of morphia in camphor water, and directed to keep the wound well wetted with a cold astringent lotion. The wound united nearly throughout by first intention, and notwithstanding a slight attack of pneumonia, which came on after the operation, he was sufficiently well on the ninth day to leave for his residence at a distance of about twenty miles from the city. Passive motion was directed to be kept up for a considerable period in the joint; and though the injunction was but imperfectly complied with, the patient has preserved a strong and useful arm, with free flexion and extension at the elbow. The superficial disease of the bones adjoining the articular structure, did not in the least interfere with the cure; and it is questionable if the result would have been so good if a larger portion of the ends of the bones had been removed, as in the ordinary process of Moreau and Syme.

Removal of the end of the humerus only. (Pl. XXIX. fig. 1.)—If there is reason to believe that the humerus is the only bone affected, it will be necessary to raise only the upper flap. Moreau under these circumstances made an incision three inches long down to the bone on either side of the humerus, terminating on the epicondyle and the epitrochlea—the two lateral tuberosities above the joint. He united the lower ends of these wounds by a transverse incision through the skin and the tendon of the triceps, just above the olecranon. The flap was then raised and drawn backwards, the soft parts separated on the sides and front of the bone, and a plate of wood or metal passed between them and the bone. The end of the humerus was next divided at the point seen in the plate with the common amputation saw. It remained then only to open the joint from behind, raise up and swing forward the fragment, and detach it from its remaining connections. If the humerus is alone diseased, the operation is now completed, and the flap is to be drawn down and fastened with the twisted or

(A B). The bands by which the soft parts are separated from the bone.

(C). The chain saw of Jeffray or Aitken, with which this bone is cut.

Fig. 5.—View of the same operation after the resected joint has been extracted through the wound, leaving the space (D).

Fig. 6.—Closure of the lips of the wound by three hare-lip sutures on either side.

Fig. 8.—View of the joint resected in figs. 4 and 5—consisting of the ends of the two bones of the fore arm and the first range of carpal bones.

(Fig. 7.) RESECTION OR EXTIRPATION OF THE RADIUS ENTIRE.

A longitudinal incision over the whole length of the radius has been made through the skin and aponeurosis, and from the lower end of this, a short transverse cut through the skin is carried over the back of the wrist. The supinator radii longus and the two radial extensors (*a*, *a*), have been separated from the inner side of the bone, the radius isolated on all sides and divided in the middle. The lower half of the radius has also been removed, after having been cut a second time so as to avoid injuring the two extensor muscles of the thumb (*b*). The posterior lip of the wound (*c*), is formed by the margin of the extensor muscles. To effect the isolation of the upper fragment, the supinator brevis (*d*), which enclosed the bone, has been divided longitudinally. The period of the operation shown, is when the surgeon, having isolated and raised the upper fragment, is about to finish the division of its last ligamentous connections with the knife from the outer condyle of the humerus (*f*). At the lower end of the wound is seen the rounded articular surface of the first range of carpal bones, from which the radius has been detached.

interrupted suture. If, on the contrary, the ends of the ulna and radius are found affected, Moreau directs the two longitudinal incisions to be prolonged downwards on the sides of the radius and ulna as far as necessary, and to separate next the bones from the soft parts on their anterior surface, so as to pass a protecting compress upon which the bones are to be divided with a saw. The ends of the two bones are then to be dissected out, preserving as far as possible the attachments of the tendons of the biceps and brachialis muscles. This method of proceeding sacrifices an unnecessary extent of the osseous structure, which, however swollen and inflamed it may be in the diaphysis, is seldom affected with caries, save in the epiphysis. It has appeared to me

that the peculiar bony layer left by the final ossification of the septum of cartilage uniting the epiphysis with the shaft, has the effect of presenting an obstacle to the progress of the caries along the bone. In cases where the shaft of the humerus is, however, found so much diseased as to necessitate the removal of a piece so long as *four inches*, which has in some instances been taken away, it is questionable whether the removal of the limb by amputation would not be the preferable resort. It has been proposed by Jeffray to cut away the thin ends of the bone without opening the cavity of the joint. But this method, besides the probability of removing an unnecessary extent of bone, is difficult of execution, and incurs a risk of injuring the radial recurrent artery, which

PLATE XXXI.—RESECTION OF THE BONES OF THE LEG AND FOOT.

(Fig. 1.) (A). OF THE FIBULA. (*Process of Seutin.*)

This operation, which admits of the removal of a greater or less portion of the body of the bone, without interfering with the joints, may occasionally be found to obviate the necessity of amputation.

A long vertical incision has been made over the bone, through the skin (*a*) and the aponeurosis (*b*), which has cut longitudinally the peroneus longus (*c*) and the peroneus secundus (*d*). The muscles have been separated so as to expose the bone, which has been divided at its middle (*e*) with the chain saw. The saw has been a second time applied at (*f*), and the fragment removed. A third application of the saw (*g*) is shown over a compress (*h*), (which protects the soft parts,) for the purpose of removing the upper fragment (*i*). At the bottom of the wound are seen the extensor (*k*) and the peroneal vessels (*l*) the trunks of which have not been injured in the operation, some few muscular branches (*m*) only being cut.

(B). EXTIRPATION OF THE CUBOID, AND RESECTION OF THE APOPHYSIS OF THE OS CALCIS.

The cuboid has been extirpated by Moreau. The object of the drawing is to show the resources of the art in caries of the external portion of the tarsus.

- a.* A quadrilateral flap of skin, reverted on the dorsal surface of the foot. With the flap is raised partially the short extensor muscle of the toes (*b*), which is detached at its origin, and serves to protect the long extensor tendons and superficial nerves, partially included in the reverted flap. The drawing represents the cuboid bone as having been completely removed.
- c.* Tendon of the peroneus secundus.
- d.* Portion of the tendon of the peroneus primus or longus, which runs under the sole of the foot.
- e.* Articular extremity of the last two metatarsal bones.
- f.* Middle cuneiform bone.
- g.* Articular extremity of the apophysis of the os calcis, seen in the process of being divided by the saw or osteotome of Heine. The same useful instrument may be employed to resect the end of all the articular surfaces that surround the excavation, from which the cuboid bone has been taken.

(Fig. 2.) RESECTION OF THE POSTERIOR PART OF THE OS CALCIS.

A Γ incision has been made, and the two triangular flaps dissected and reflected so as to expose the posterior part of the bone. Two converging sections of the calcis have been made with the saw between the insertion of the tendo achillis and the place of origin of the plantar muscles from this bone. A third perpendicular cut has been made with the saw, uniting the first two in a truncated angle.

(Fig. 3.) EXTIRPATION OF THE SCAPHOID BONE, AND RESECTION OF THE INTERNAL CUNEIFORM.

This operation, which has not yet been done on the living subject, is given by M. Bourgery as an example of what might be undertaken in case of caries of the internal border of the tarsus, involving either the articulation of the scaphoid with the astragalus or cuneiform bones, or the latter bones at their place of junction with the metatarsal.

Fig 4.

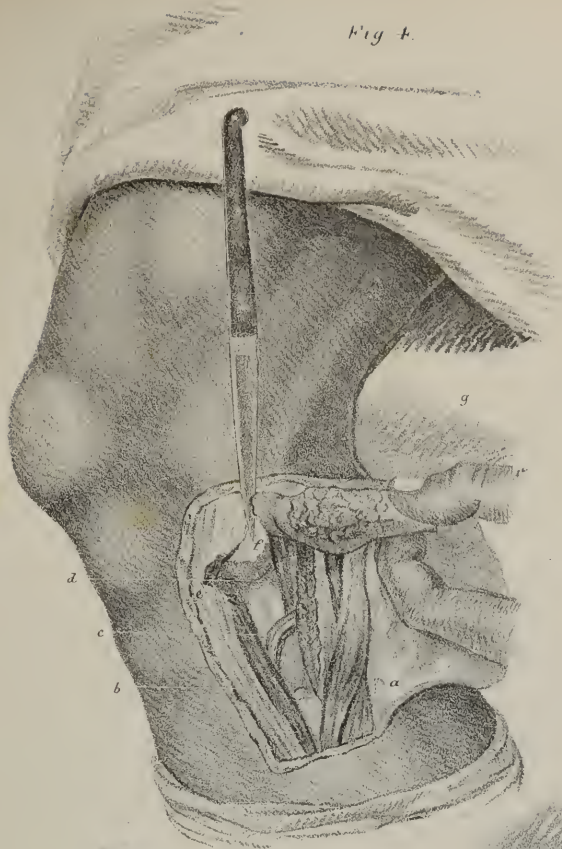


Fig 1

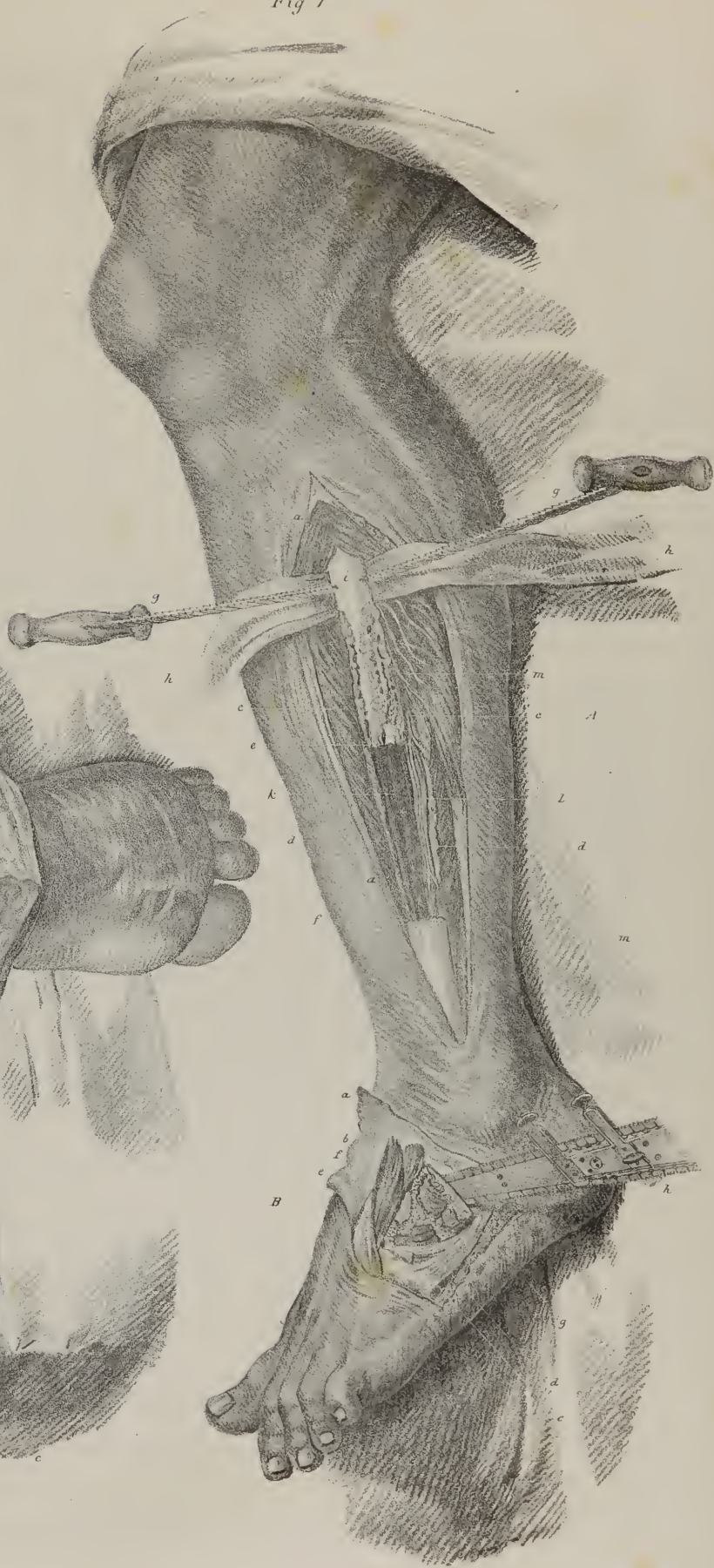


Fig 2

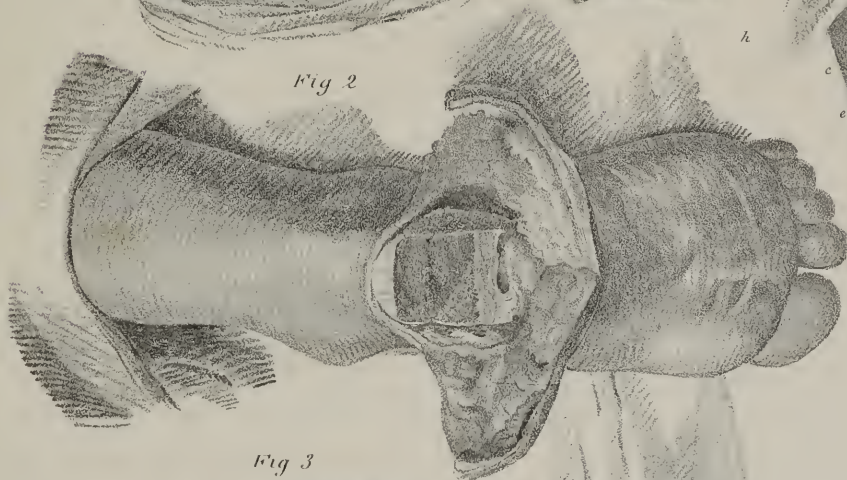


Fig 3



is found along the outer oblique edge of the brachialis anticus muscle, immediately adjoining the capsular ligament, and sends a branch the size of a knitting needle to the humerus just above the external condyle. The plan of Syme, of first opening the joint, and proceeding as described in the case detailed by the author, will be found to give the best results.

RESECTION OF THE RADIUS. (PL. XXX. FIG. 7.)

The complete extirpation of this bone was effected by Dr. Butt, of Virginia, in 1825. It may be accomplished without much difficulty by the following process, described by Velpeau. The fore arm slightly flexed, and in the middle position between pronation and supination, the surgeon makes on the anterior and external side of the radius, a longitudinal incision, from the external tuberosity of the os humeri to the styloid process of the radius, dividing all the intermediate parts down to the bone. From the lower extremity of this, a transverse incision is to be carried over the middle of the back of the wrist, in order to facilitate the disarticulation of the carpal end of the bone. In the longitudinal incision, the course of the supinator longus is to be followed as much as possible, the short supinator being the only muscle that is to be divided across. The lips of the incision are to be held asunder by an assistant; the muscles are to be detached from the middle part of the bone, and the latter divided with a chain saw or the cutting forceps. Each fragment is then to be raised separately and detached from the surrounding parts, keeping the edge of the knife applied close to the bone as it approaches the articulations at its ends. In removing the inferior fragment, it has been advised to saw it a second time below the extensors of the thumb, as it is otherwise difficult to avoid cutting them across.

Partial resection of the radius where the extremities are not diseased.—This may be effected by a slight modification of the preceding operation, so as to leave undisturbed the two extremities of the bone and the joints to which they belong,—the insertion of the biceps muscle above, and the grooves for the extensor muscles. The single longitudinal incision will be all that is required. The bone is to be divided across near its two extremities, and the operation completed as in the foregoing method.

Dressing.—The forearm having, after this operation, a tendency

to curve itself to the external side, the limb should be sustained with a straight splint on its inner margin. Cicatrization takes place rapidly, and a new osseo-fibrous substance is ultimately found connecting the two ends of the bones, and preserving the natural straightness of the limb.

Excision of the shaft of the ulna is never practised, except to a limited extent, as in cases of necrosis, or traumatic injuries, for which the rules have already been given.

RESECTION OF THE WRIST JOINT. (PL. XXX.)

Comminuted and complicated fractures and dislocations, caries and necrosis, are the principal causes which have led to the excision of the lower ends of the bones of the forearm in a few instances, in some of which the operation has been attended with success. The end of the ulna, which had separately undergone a compound luxation, has been many times happily removed, in cases where it has been difficult to replace and maintain it in its former position. The carpal end of the radius has also been resected separately under somewhat similar circumstances.

The complete resection of this joint is necessarily a protracted and difficult operation. The dissection of the tendons, even if we divide the carpal flexors and extensors, (as being no longer of any use,) according to the direction of M. Bonnet, and the section of the articular ligament will demand a knowledge of the structure more precise than is possessed by practitioners in general. The wound will be filled with fibrous and tendinous structures and more or less synovial tissue, whether we leave or remove one or both of the rows of carpal bones, which will render the chance of a satisfactory cure at least doubtful. In recent extensive injuries of the bones, the operation may unquestionably often be practised with advantage; but in a great majority of chronic cases, when the lesion is of so long standing and so extensive as to leave no chance of cure short of resection or amputation, the latter, with the substitution of an artificial hand, will generally be preferred.

Of the various processes employed, those of Roux, Dubled and Bourgery, seem to merit the preference, and can be modified according as the necessity exists of removing a larger or smaller portion of bone.

Process of Textor and Roux.—We may remove by this process

- a. A quadrilateral flap of skin, reflected from the inner upon the dorsal surface of the foot.
- b. Tendon of the long flexor of the great toe.
- c. Adductor muscle of the great toe.
- d. Tendon of the posterior tibial muscles cut across.
- e. Vertical section of the scaphoid by the osteotome of Heine, all the internal mass of the bone being removed.
- f. Section, with the same instrument, of the posterior or scaphoid end of the internal cuneiform bone.

(Fig. 4.) RESECTION OF THE HEAD OF THE FIBULA. (*Process of Bourgery.*)

- a. Cutaneous flap, reflected on the posterior surface of the leg.
- b. Vertical section of the upper part of the peroneus longus muscle, in order to lay bare the bone.
- c. Anterior tibial vessels, uninjured. They are seen forming the arch by which they get from the posterior to the anterior face of the leg through the interosseous ligament.
- d. Superior attachment of the soleus muscle.
- f. Articular surface of the tibia, which may also be resected if found diseased.
- g. Diseased extremity of the fibula, about to be removed with the bistoury.

the ends of either one of the bones separately, or take them both away at the same operation. In the latter case, it is not a matter of much importance whether the radius or the ulna be the first of the two bones detached. At times, it becomes necessary to remove in addition the proper carpal bones. Each of these indications forms a distinct stage in the operation.

1. *Resection of the inferior extremity of the radius.* (Pl. XXX. fig. 2.)—The palm of the hand is to be rested on a table. The surgeon makes an incision along the external border of the radius, extending from the styloid process an inch and a half upwards. From the lower end of this, another, three-quarters of an inch long, is to be made across the back of the wrist. The triangular flap thus formed is to be dissected up, carefully denuding the bone with the bistoury, and turning off the tendons and vessels. A chain saw is now to be carried by means of a curved needle round the bone, and the latter cut across from within outwards. The fragment is then to be raised and turned downwards, the pronator and the ligamentous connections of the bone divided with the knife, an assistant at the same time drawing to one side the extensor tendons with a blunt hook.

2. *Resection of the inferior extremity of the ulna.*—The hand is to be strongly twisted outwards so as to expose the outer and back surface of the ulna. The flap is to be raised and the bone excised precisely as in the manner above detailed for the radius. It is to be observed, that between the two flaps thus raised on the side and back of the forearm there intervenes a portion of undivided integument, which serves to protect the extensor tendons.

3. *Resection of the carpal bones.*—If these bones are involved in the lesion, the superior range of bones may, without extending the lateral incision, be partially excised or removed entire.

Dubled employs only the first or longitudinal incision of Roux, removing first the end of the ulna, and subsequently acting on the radius. This plan will occasionally be found serviceable in removing fragments of the bones after recent injuries. Velpeau has modified this method of Dubled, by uniting the long incisions by another transverse one over the back of the wrist, and turning down the quadrilateral flap thus formed, so as to act upon both bones at once with a common saw; but if it be necessary to remove the carpal bones, the flap is to be separated further downwards towards the fingers.

Process of Bourgety. (Pl. XXX. figs. 4, 5, 6.)—This is an application of the method already described in reference to the shoulder joint. A longitudinal incision is to be made on either side of the arm, and the intervening soft parts separated from the bones in the form of a bridge. The diseased part is then to be removed with a chain saw—one section being made above the wrist, and the other through the range of carpal bones below the limits of the disease. The operation, however, is attended with considerable difficulty, and has not yet been applied upon the living subject.

RESECTION OF THE METACARPAL BONES.

The excision of a portion of the metacarpal bones has been many times practised with success, and presents in its results incontestable advantages over the process for their disarticulation entire. It has been most frequently practised upon the first me-

tacarpal bone in cases of caries, comminuted fracture or luxation; and is more or less applicable to all, with the exception of the fifth, where it would leave a hand of less service to the patient than after the complete removal of this bone and its corresponding finger.

Resection of the first metacarpal bone.—A longitudinal or crucial incision, or one in the shape of an L, is to be made over the back of the bone, corresponding to the part that is to be removed; the lips of the incision are then to be separated, and the extensor tendons drawn to one side. The interosseal muscles are next to be detached from the sides of the bone, and the joint belonging to the extremity to be removed laid open. The bone is then to be snipped across with a strong pair of cutting forceps, and the fragment raised up and detached with a few touches of the knife.

Dressing.—The wound is to be closed with adhesive straps, and supported by a few turns of the roller. A new dense and partly osseous tissue will, it is asserted, be subsequently formed, serving as a substitute for the portion removed.

RESECTION OF THE METACARPO-PHALANGEAL JOINTS.

Caries, and comminuted fracture with crushing of these bones, have been the most frequent causes for which they have been excised. The head of the metacarpal bone or that of the phalanx, may either be removed separately; but in case of the thumb, both, if they are involved in the lesion, may be taken away together. But in reference to the fingers, it would be better in a great majority of cases to remove the parts by amputation, excising at the same time, if it be necessary, the end of the metacarpal bone.

Operation.—If there be fistulous orifices about the part, these are to be laid open so as to expose the bone. Where this is not the case, an incision half an inch to an inch long is to be made on the back of the metacarpal bone, extending down to one of the commissures of the finger. From near the top of this a second incision is to be carried to the other commissure, and the V shaped flap between is to be raised and turned downwards. The extensor tendon is then to be loosened and drawn to one side, and the interosseous muscles separated from the sides of the bone. The lateral and anterior ligaments of the joint are next to be divided, without injuring the flexor tendons. The phalanx is now to be luxated backwards, and the diseased portion removed with the forceps or a small saw. If the head of the metacarpal bone is diseased, it is to be raised and divided in the same manner. During the progress of cure the two ends of the bones may become united by fibro-ligamentous tissue, so that it is possible that the tendons may again effect the movement of the joint.

Extraction of the first phalanx.—This has been practised by Babe and Velpeau upon the thumb, so as to preserve the uses of the terminal phalanx. But we have so many means for curing the affections of the phalanges, that their extraction cannot, it appears to me, be an operation often indicated.

Operation.—An incision is to be made over the back of the metacarpophalangeal articulation, and extended a quarter of an inch beyond the articulation of the first phalanx with the second. The integuments are to be dissected off, and the extensor tendon drawn to one side. The metacarpophalangeal articulation is then

to be opened, as in the process last described. The phalanx is next to be luxated forwards, loosened upon its sides with the knife, and finally removed by opening its inferior articulation.

RESECTION OF THE HEAD OF THE OS FEMORIS.

The excision of the head of the thigh bone was practised for the first time by C. White, of Manchester, in 1769, and it is said with success. The operation has in all been done in eleven instances, five only of which, though the statement is not considered wholly incontestable, have been reported as successful—the patients in the greater number of cases dying in consequence of the extension of the caries, the violence of the consecutive inflammation, or of the exhaustion produced from excessive suppuration. The cases were all those of coxalgia, in which the caries of the bone was already more or less manifested.

Notwithstanding the common fatality attending the ordinary treatment of coxalgia with caries of the head of the bone, there seems as yet little or no reason to believe that the chances of the patient would be improved by resorting to so severe an operation as that of excision of the deeply seated head of the femur. It could scarcely be considered justifiable, except in the advanced stage of the disease; and then, as I have frequently observed on dissection, the acetabulum itself may be involved at its margins, perforated at its bottom by carious ulceration, and the periosteum detached to more or less extent on its pelvic surface, so as to set at defiance all attempts at cure by excision of the diseased portions.

In recent gunshot injuries of the head and neck of the bone, for which it has been recommended by Guthrie and Ballingall, there is however a prospect that it may be employed with advantage in place of the frightful and precarious alternative of amputation at the hip joint. It was tried by M. Seutin, in 1832, for an injury of this description received at the siege of Antwerp, but without success, the patient dying of gangrene on the fourth day after the operation. Several methods have been proposed to get at the joint where there exists no internal opening which admits of being enlarged for this purpose.

1. *Simple longitudinal incision.*—This is the process of White; and the one employed, with a little modification, by Seutin. It is to be made on the outer and upper part of the thigh, and the knife at once carried down to the bone, commencing a little below the crest of the ilium, passing over the great trochanter, and continued for two or three inches below this prominence. The lips of the wound are to be well separated, and the capsular and round ligaments divided across. If the trochanter major is not diseased, the tendons attached to it are not to be divided. The knee is then to be carried inwards and upwards, and the head of the bone luxated through the wound and cut off with a saw. This process, however, will be found attended with considerable embarrassment, unless the head of the bone is detached, or the ligaments have previously given way.

2. *Formation of a flap.*—Seutin transformed the longitudinal into a crucial incision, by dividing the integuments over the top of the great trochanter, so as to form four triangular flaps, which were next dissected up. This afforded him space for the removal of fifteen splinters, and six inches of the top of the femur.

Rossi proposes to add to the inferior end of the longitudinal incision of White, a deep horizontal one, extending backwards towards the posterior and internal part of the thigh, thus forming a triangular flap, which is to be dissected up.

Roux forms on the external side of the limb a large quadrilateral flap, which is to be raised and turned upwards towards the abdomen.

The semi-oval or triangular incision of Jæger, and the semilunar incision of Velpeau, appear to merit the preference.

Process of Velpeau.—A semilunar incision having been carried behind the articulation from the anterior and superior spine of the ilium to near the tuberosity of the ischium, a large flap is to be cut with its base downwards, through the thickness of the muscles at the root of the limb. The flap is then to be raised, and the capsule opened on its posterior part. The thigh is next to be flexed and carried inwards, the round ligament divided, and a knife—passed between the head of the femur and cotyloid cavity—carried down along the neck so as to divide the remains of the capsular ligament, and allow the head of the bone to be pressed outward through the wound. The diseased portion is next to be removed with the saw. The limb is then to be placed in its natural direction, and the flap fastened down with the twisted or interrupted suture. To this operation, which is necessarily very extensive, and involves the gluteus medius and minimus muscles, the pyramidalis and the obturators, I should prefer the following process, with the second incision rendered so as to more completely circumscribe the joint.

Process of Jæger.—A longitudinal incision on the external part of the thigh is to be commenced two inches above, and extended (cutting down to the bone) three inches below the trochanter. From the top of this incision, another four inches long is to be carried backward and downward. The triangular flap thus formed, is to be dissected off from the trochanter, and the bone turned out and excised as in the process of Velpeau. If the cotyloid cavity is found diseased, Jæger proposes to excise it with a Hey's saw, or cauterize it with a heated iron.

RESECTION OF THE KNEE JOINT.

This operation, first performed by Park, of Liverpool, in 1781, in a case of white swelling, has been several times repeated by different surgeons. Of fourteen cases collected by Textor, four only have been considered completely successful, and in these the success was accompanied with considerable shortening of the limb, some deviation outwards when ankylosis did not take place, and permanent fistulous orifices. The great breadth of the articular surfaces, the necessity of dividing the attachment of many important muscles, and the small remnant of tissue left to connect the thigh with the leg, at least after the ordinary processes for excision, and the previous exhaustion of the patient from protracted disease, are so many reasons to contraindicate the operation in scrofulous affections of the joint.

These various considerations serve to explain the discredit into which this operation has generally fallen, and the common preference which is given to amputation of the thigh, and the substitution of a wooden limb. Nevertheless, cases may occur in gunshot or other recent injuries, when the constitution is sound

and vigorous, that would justify the attempt to obviate the necessity of amputation, by partial excision of the bones of the joint.

Process of Moreau.—Two longitudinal incisions are to be started from the sides of the joint, and carried up as high on the femur as the disease is supposed to extend, dividing at the same time all the parts down to the bone. The lower extremities of these are to be united by a transverse incision, which should pass just below the patella, and divide at the same time the skin, fascia, and ligaments, down to the joint. The flap thus formed is to be dissected off from the surface of the femur, and turned upwards, carrying with it the patella. A scalpel should then be carried

along the posterior face of the femur, shaving it closely so as to detach it from the soft parts without injuring the popliteal vessels. A wooden splint, or a piece of thick leather, is to be passed between the soft parts and the posterior face of the thigh bone, and the diseased surface of the condyles divided from above downwards with an amputating saw. If the head of the tibia should also be found carious, the two lateral incisions are to be extended downwards, and another middle longitudinal one made, if it be necessary, from the front of the joint down to the spine of the tibia. The integuments are then to be dissected off and turned downwards, in the form of a single or double flap. The posterior face of the tibia is next to be separated from the soft parts, a

PLATE XXXII.—RESECTION OF THE BONES OF THE ANKLE AND FOOT.

(Fig. 1.) RESECTION OF THE ANKLE JOINT. (*Right side.*)

In this operation either one or both the lower ends of the two leg bones may be resected, as well as the upper end of the astragalus, in case the latter should also be found diseased. Independently of the danger and difficulty attending this operation, it leaves, even when successful, a limb of but little utility. Amputation is, therefore, justly preferred by most surgeons. The separate resection of the end of the fibula is perhaps all that would ever be justifiable.

Lower end of the tibia.—This operation, which is shown chiefly for the purpose of illustrating its serious nature, is represented at the moment of termination.

- a. A rectangular flap of skin, reflected forwards on the leg.
- b. Section of the shaft of the tibia.
- c. Tendons of the anterior tibial and extensor muscles.
- d. Tendons of the flexor longus and posterior tibial muscles.
- e. Portion of the inferior end of the fibula.
- f. Peroneus tertius.
- g. Long flexor of the great toe.
- h. Internal saphena vein.
- i. Surface of the astragalus.
- k. Inferior end of the tibia luxated, about to be separated with the bistoury (*l*). Resection of the other bone of the leg is shown at fig. 3.

On the same drawing is shown the extirpation of the metatarsal bone of the great toe. A flap of skin (*m*) is reverted on the back of the foot, exposing the extensor tendon of the great toe (*n*), and that of the long flexor (*o*). The bone has been disarticulated at either end and drawn outwards, bringing into view the interosseous muscle (*p*), the first cuneiform bone (*q*), and the first phalanx of the great toe (*r*) with its sesamoid bones. At the bottom of the wound are seen the interosseous vessels.

(Fig. 2.) RESECTION OF THE METATARSO-PHALANGEAL ARTICULATION OF THE GREAT TOE, AS PRACTISED WITH SUCCESS BY THE AUTHOR IN TWO CASES OF CARIES OF THE JOINT.

- a. Semilunar flap, reverted on the inner face of the bone. The line of incision has run through two fistulous orifices (*f, f*).
- b. End of the metatarsal bone, which has been loosened at the joint, isolated, raised on a thin splint, and divided with the saw.
- c. Posterior end of the first phalanx of the toe; carious, and subsequently removed.
- d, e. Extensor and flexor tendons of the toe.

(Fig. 3.) RESECTION OF THE LOWER END OF THE FIBULA.

The operation is shown at the moment of making the section of the shaft with a chain saw.

- a. Cutaneous flap reverted.

Fig 1

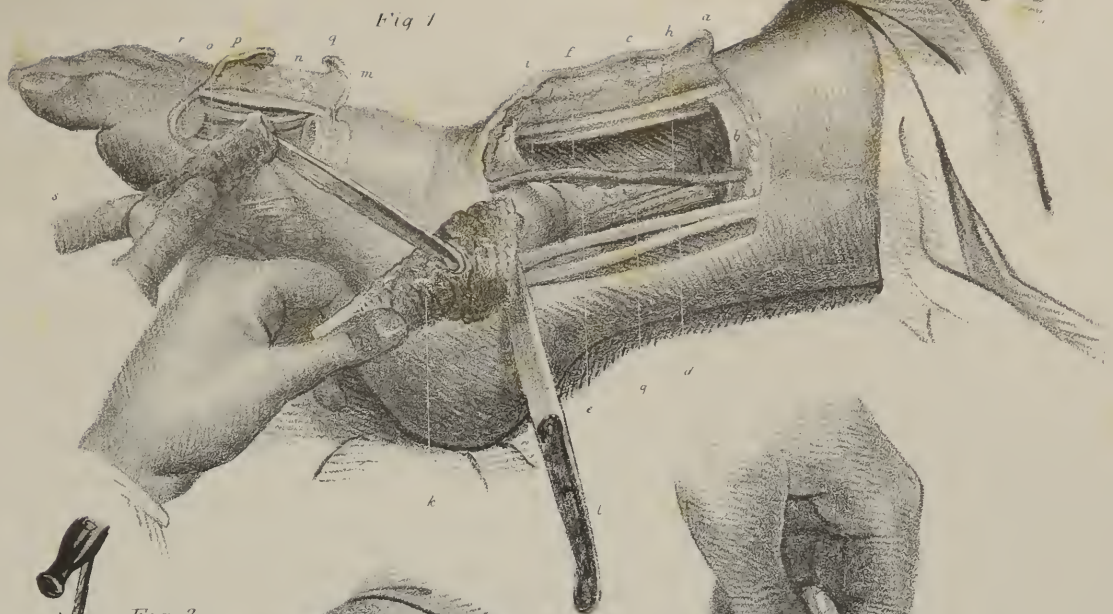


Fig 3

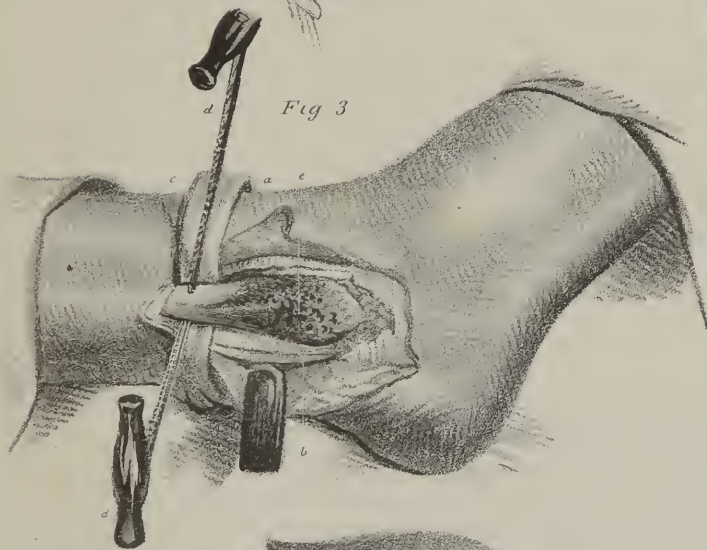
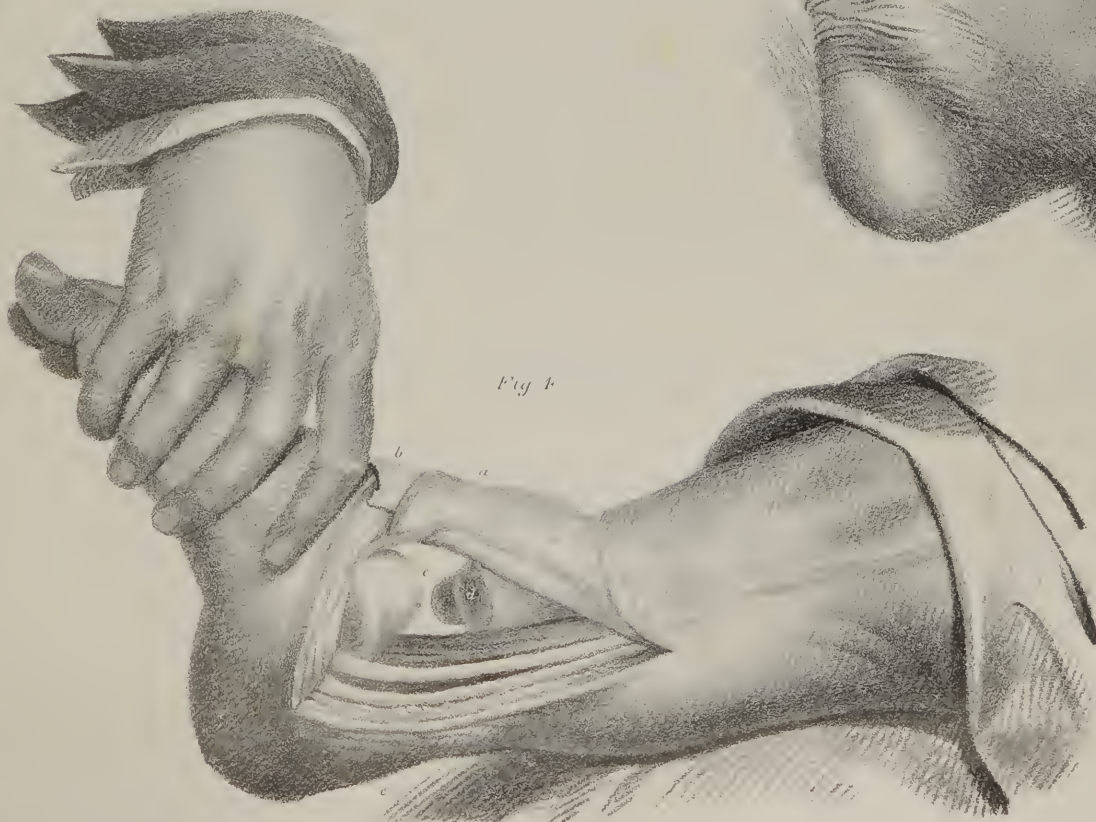


Fig 2



Fig 4



splint or spatula passed behind it for the protection of the latter, and the articular surface detached with the saw.

Bégin and Sanson have proposed to modify the first steps of the operation by half flexing the limb, and commencing the operation with the transverse incision, carrying a narrow long-bladed catling directly down upon the front of the joint, dividing the ligament of the patella, and all the parts inclusively from one lateral ligament to the other. The longitudinal incisions are then to be made, and the operation continued as in the process of Moreau. The modification just described renders the operation much more rapid, and should be adopted whenever the state of the joint will allow the limb to be placed in the requisite position.

Dressing.—The divided osseous surfaces are to be placed nearly in contact, the margins of the flaps secured with the twisted suture which should only embrace the skin, and the limb surrounded with the bandage of Scultetus, and supported in the extended position with the apparatus for fractured thigh. It is recommended by Jæger and Syme to excise also the patella; but if this be not diseased, it should unquestionably be left, as it will serve to furnish a broader basis for the subsequent union of the bones. A hollowed splint, well padded and placed below the knee, would, I believe, be found a useful adjuvant in preserving—which is so absolutely necessary for the first few days—the perfect immobility of the divided parts.

RESECTION OF THE FIBULA.

As this bone in regard to its size and uses forms but a secondary part in the structure of the superior two-thirds of the leg, its upper extremity, or even a considerable portion of its shaft, may be removed, when diseased beyond all other chance of cure.

Excision of the upper extremity. (Pl. XXXI. fig. 4.)—This operation was first performed by Beclard, (1819).

Process of Bourguery.—The leg is to be partly flexed and laid upon its inner side. A longitudinal incision is to be commenced half an inch above and a little more in front of the head of the bone, (which may be felt with the finger,) and extended downward as far as the bone is diseased. From either end of this, two transverse incisions are to be made posteriorly, and the flap thus formed dissected and turned off. The fibres of the peroneus longus are now to be detached, and the bone denuded at the point

at which we wish to divide it across. The end of the fragment is then to be raised, and swung a little from side to side to favour its detachment from its articulation with the head of the tibia. During this step, care must be taken to cut close to the bone, in order to avoid the anterior tibial nerve.

Excision of the shaft. (Pl. XXXI. fig. 1.)—This operation was done by M. Seutin for necrosis, by the following process. The leg lying on its inner side, an incision was made along the external border of the fibula, proportioned to the extent of the disease, dividing the skin and peronei muscles down to the bone. The lips of the incision were held asunder by an assistant, while the surgeon separated them on either side from the bone; a compress was then introduced below, so as to protect the soft parts, over which he passed the chain saw and divided the bone from within outwards, at either end of the diseased portion. The cutting forceps would, however, answer well for the division of the bone. If the soft parts are shaved carefully from the surface of the bone, the peroneal vessels will not be injured; and the wound, which is regular and superficial, will be quickly found to cicatrize.

RESECTION OF THE ANKLE JOINT.

This is an operation many times performed by the older surgeons in cases of caries, white swelling, and complicated fracture and luxation. But even when the wound healed up kindly, which it is little disposed to do, the limb was left so stiff and weak that the patient was only able to move about with the aid of a pair of crutches or a cane. The operation may, therefore, be considered obsolete; or, if employed at all, proper only in cases of traumatic injuries of the joint. Many processes have been devised, but the following has been the most often followed.

Process of Moreau. Two incisions in []. (Pl. XXXII. fig. 4.)—A longitudinal incision three inches long is to be made over the external border of the fibula, terminating a little below the external malleolus. A transverse incision is to be extended in front from the lower end of this round the malleolus, as far as the tendon of the peroneus tertius. The flap of skin is to be dissected and turned up; the tendons of the two lateral peroneal muscles are to be separated from the bone, and the latter divided across just above the level of the joint with a mallet or chisel, or, which would be found to answer better, the chain saw or large cutting

b. Tendons of the two large peronei muscles.

c. Band passed below the bone to protect the soft parts, over which the chain saw (*d*) has been passed for the purpose of dividing the bone. The bone is subsequently to be raised and detached with the bistoury in the manner shown at fig. 1.

(Fig. 4.) RESECTION OF THE ANKLE JOINT ENTIRE. (*Process of Moreau.*)

The objections to this operation are the same as those noticed in relation to fig. 1. By the operation seen at fig. 4, but a small portion only of the ends of the bones can be removed. It is shown at the moment of termination. If necessary the articular surface of the astragalus may be removed by the same process. Two L shaped incisions have been made over either bone of the leg, and the two cutaneous flaps (*a*, *b*) reverted. On the side of the wound (*c*) are seen the tendons and flexor muscles of the toes, as well as the posterior tibial vessels and nerve, and the peroneal vessels. The internal saphena vein is seen passing down on the inner face of the flap (*a*). The place where the two bones of the leg are divided is seen at *d*. The articular surface of the astragalus (*e*) may, if found diseased, be readily removed by the osteotome of Heine.

forceps. The fragment is now to be swung out from its bed and detached from its ligamentous connections with the knife. In order to remove the tibia, a similar flap is to be formed over the inner side of the joint—the transverse incision extending in this instance as far as the tendon of the anterior tibial muscle. The flap having been reflected upwards, the muscles and vessels are to be carefully separated from the anterior and posterior faces of the bone, as far up as it may be considered necessary to remove the piece. The division of the bone may then be made from behind forwards, or from before backwards, as is found most convenient, with a narrow-bladed saw, which is to be conducted through the wound on the surface of the finger—the soft parts on the opposite side of the bone being protected by a compress against injury from the teeth of the saw. The fragment is then to be pulled over and detached from its ligamentous connections as in the former case, taking care to avoid injuring the posterior tibial nerve and vessels, as well as the three large tendons which pass downwards to the hollow of the os calcis. If the surface of the astragalus participates in the disease, it may be cut away with the gouge or the chain saw. If the tibia only be diseased, it is considered best to remove with it the end of the fibula, in order to prevent a tendency in the foot to deviate to the other side.

Dressing.—The flaps are to be fastened down with some points of suture, the osseous surfaces brought together, and held immovably fixed in an appropriate apparatus.

RESECTION OF THE TARSAL BONES.

Caries, compound fractures, and complicated dislocations are the more ordinary causes for which excision has been practised upon the various tarsal bones. Though success has in several instances succeeded the operation for caries of these bones, it has on the whole been so little common, in consequence of the extent to which the synovial membranes of the different joints of the tarsus are involved, the affection of the surrounding tissues, and the liability of the disease to return from the difficulty in extirpating it completely, that the operation has not received by any means the general sanction of the profession. Still, under favourable circumstances, it might be tried with propriety as an alternative against amputation. The partial excision of the back part of the os calcis, as it involves no joint, may be often practised with the greatest advantage in cases of caries of that bone. In severe traumatic injuries of the bones, the operation offers greater prospect of success, and especially in cases where the astragalus is broken in pieces or thrown forwards upon the dorsum. Two instances of comminuted and compound fracture of the astragalus in young persons have nevertheless done well in my hands without operation—the adherent pieces of bone which were allowed to remain being subsequently consolidated so as to preserve the foot, though the cure was attended with ankylosis and an outward convexity of the ankle joint.

Resection of the astragalus.—For the excision of any of the tarsal bones, general rules only can be given. In cases of luxation this bone will form a prominent tumour on the back of the foot, over which the skin will be tightly strained. This must be opened at any point most favourable to the extraction of the bone, taking care to avoid at the time any injury of the neighbouring

tendons or of the anterior tibial vessels. Some difficulty will be found in separating the interosseous ligament, which unites it to the calcis, in cases where it is not to a considerable extent torn in the displacement. After the cure, the joint will most *usually* be found ankylosed.

Resection of the os calcis. (Pl. XXXI. fig. 2.)—From the great size of this bone, and its position directly below those of the leg, excision is practised only for the diseases of its posterior prominence, or of its outer or inner margins. The skin is to be laid open by an incision in Γ , or a crucial cut; my own practice is to make first a semicircular incision just above the callous margin of the heel, and then split the flap thus marked out by a cut to the bone down the median line of the heel. The flaps are to be dissected off from the surface of the bone. If the caries be superficial, it may be removed with a strong knife, the gouge, or a Hey's saw. If more deep, the whole protuberance may be removed as seen in the drawing—by dividing it first with the saw from above downwards, so as to leave the attachment of the tendo-achillis; and again from below upwards, so as not to disturb the attachment of the plantar muscles; the piece finally being detached with a narrow-bladed saw, or with a chisel. If the caries extend into the body of the bone, it is to be scooped out with a gouge or a curved scalpel.

Velpeau recommends for the purpose of opening the skin, a semilunar incision, as more likely to unite better, and leave a less troublesome cicatrix. But whatever course be pursued in this respect, the scar remains tender to pressure, and is liable to ulcerate.

Resection of the cuboid and cuneiform bones. (Pl. XXXI. fig. 1, 3.)—In a case of caries of the bones on the outer side of the foot, accompanied with a fistulous ulcer, the elder Moreau raised a quadrilateral flap of skin, with its base inwards, and turned it over the dorsum of the foot. The tendon of the peroneus longus was drawn outwards, and the belly of the short extensor of the toes cut and turned inwards, so as to expose the affected bones. From the extent of the caries he was obliged to remove the cuboid, the third cuneiform, the posterior extremity of the fourth metatarsal bone, the internal side of the extremity of the fifth, and lastly the articular surface by which the calcis was united to the cuboid. The operation was successful; the great cavity formed, was in a great measure subsequently filled up with osteo-fibrous matter, and the patient regained the movements of the foot so as to be able to walk with facility.

In a nearly similar case, Velpeau excised in the following manner one-half of the cuboid and the bases of the fifth and fourth metatarsal bones. A longitudinal incision was made along the external border of the foot; another was drawn perpendicularly from this over the junction of the tarsus and metatarsus, and the two triangular flaps thus formed dissected up. The bones were then denuded, cut through with the wheel saw, and removed. The cavity left was about three-quarters of an inch deep. The wound was filled with charpie, and the flaps closed over it. At the end of three months, the cicatrization was complete, and the patient recovered almost without deformity.

RESECTION OF THE FIRST METATARSAL BONE.

In regard to each of the four smaller metatarsal bones, excision

with preservation of the corresponding phalanges is never attempted, amputation of the whole being preferred, as the toes if left could only serve as an incumbrance. But for disease limited to the first metatarsal bone, partial excision has been occasionally practised, in order to preserve more effectually the points of sustentation at the foot. A quadrilateral, a crucial, or T shaped flap is to be turned from off the bone. The extensor tendon is then to be pushed to one side, and the metacarpo-phalangeal articulation opened. The head of the bone is next to be luxated, and a knife passed behind it so as to separate its body from the soft parts so far as the disease extends. A protecting compress is then to be passed below, and the bone divided with a saw or cutting forceps.

RESECTION OF THE FIRST METATARSO-PHALANGEAL ARTICULATION. (PL. XXXII. FIG. 2.)

Process of the author.—In 1836, I removed at the Philadelphia Hospital the entire metatarso-phalangeal joint of the first toe, preserving two-thirds of the first and the whole of the second phalanx. The case was one of caries, caused by a spike-nail run through the joint. The whole structure of the articulation was swollen and thickened, and two fistulous openings existed low down on the side of the foot. I made a semicircular incision, which traversed these openings, and dissected the flap, the base of which was towards the heel, so as to turn it backwards upon the foot. This exposed completely the inner surface of the joint, and about half the length of the metatarsal bone. The joint was next opened, the metatarsal bone isolated from the tendon and the surrounding parts, and divided across near its middle with the metacarpal saw. On the removal of the fragment, the end of the phalanx was found carious; this was pushed out through the wound, and a portion of an inch long removed with the saw. The interior structure of the adjoining part of the phalanx, which was soft and spongy, was scooped out with the end of the scalpel. The ends of the divided bones were then put in contact, and the flap brought down and secured with adhesive straps and a retaining bandage. Some suppurative discharge continued for three weeks at the posterior angle of the wound; but it ultimately healed up well. Solid union took place between the divided bones, and the patient preserved his toe, which was found after the cure about three-quarters of an inch shorter than the other. The only difficulty encountered in the after treatment, was the tendency of the extensor muscle to elevate the point of the toe. Should I again have occasion to excise this joint, I would prefer to divide this tendon, in case I approximated the bones, inasmuch as the necessity for its use would be greatly diminished afterwards; as the middle phalangeal joint, in regard to position and office, supplies the place of the one excised, and there would be reason to expect that the reunion of the divided tendon would be sufficiently perfect to prevent (in conjunction with the dressing) the flexor muscle from drawing the point downwards.

Since the publication of the first edition of this work, the author has, in another instance, resected this joint for caries by the preceding process. The operation was performed at the Philadelphia Hospital during his clinical service for the winter of 1844-5.

The precaution of dividing the extensor tendon was observed; and this not only served to prevent the elevation of the toe but diminished its tendency to retraction, so that the cure took place with scarcely any shortening or deformity.

M. Petriquin reports a similar operation done by Professor Regnoli, of Pisa, in the case of a girl twenty years of age, and which he saw in the progress of cure. By this mode of operation we preserve well the shape of the foot. In cases where I have removed the metatarsal bone and phalanges of the great toe, there has been a tendency in the remaining toes to turn inwards, from the want of resistance. In one case, so much inconvenience was felt from the second toe rubbing against the side of the boot, that I was compelled to extirpate it at the root.

RESECTION OF THE FIRST METATARSAL BONE ENTIRE. (PL. XXXII. FIG. 1.)

The bone is to be uncovered on its side by the raising of a quadrilateral flap, with its base upwards, unless there be some fistulous openings in the skin through which it is desirable to pass the knife, and which may make it necessary to modify the shape of the flap raised into that of a T, an X, or an L. The bone is to be carefully isolated from its extensor tendon and the interosseous vessels, (which are to be drawn to one side,) and separated from the phalanx at the metatarso-phalangeal joint. It is then to be drawn from its bed, loosened from all its connections on the outer face with the knife, and removed at its articulation with the cuneiform bone. Velpeau finds it more convenient to divide the bone in the middle with the chain saw, and remove each fragment separately.

In the only instance which has come under my notice of the entire removal of this bone,—that of a gentleman from Pittsburg, in this state,—no fibro-osseous substitute for the bone had been formed, and the toe perfectly loose posteriorly, was placed by the action of the extensor muscle nearly upright on the dorsum so as to form a useless incumbrance. On the whole, it would be unquestionably better, when there is no portion of metatarsal bone left to give the phalanges a solid support, that these should be removed at the same time with the former.

IV. AMPUTATIONS.

THE OPERATIONS FOR AMPUTATIONS OF THE EXTREMITIES ARE DIVIDED INTO TWO GREAT CLASSES, ACCORDING AS THE FINAL SEPARATION IS MADE ACROSS THE CONTINUITY OF THE BONES, OR AT THE PLACES OF THE JOINTS WHERE THE ENDS OF THE BONES ARE MERELY CONTIGUOUS.

AMPUTATIONS IN GENERAL.

In a treatise on operative surgery like the present, it must be evident that an attempt to point out the kind of accidental injuries and diseases that render amputation proper, would lead far beyond its proper scope. To state, as is common with authors, that the

affections which more or less frequently require amputation are malignant diseases, such as the various forms of cancer, many non-malignant tumours that have become incurable, or have destroyed the usefulness of a limb; some of the severer forms of necrosis, caries, gangrene, white swellings, compound or complicated fractures, and dislocations and wounds, would be but a mere barren enumeration of causes, of little value to the student. The question involved in determining as to the propriety of amputation is, in many cases, one of exceeding delicacy and importance, and rests upon circumstances so numerous and variable, that it is impossible briefly to point them out,—the nature, the seat, the extent, the duration of the lesion, the degree to which the system has already sympathized with the disease, the age and constitution of the patient, the favourable or unfavourable circumstances in which he is placed,—each one of which may, on particular occasions, exercise a governing influence in the judgment of the surgeon. The reader, therefore, is referred, in respect to the indications of amputation, to the various treatises on surgery, in which he will find a particular consideration of the different forms of injuries and diseases that necessitate this operation; and especially is he recommended to embrace every occasion for the study of surgical pathology; a subject of the most vital importance to the practitioner, and which, though it has not yet received the due degree of cultivation to which it is entitled, has done much towards teaching the mode of curing numerous diseases, that formerly subjected the patient to the mutilation of the amputating knife. To come to a right decision in every case submitted to his judgment, it is necessary for the surgeon to determine as positively as possible, the present condition of his patient, what are the exact parts involved in the disease, and what is the character of the morbid alterations both local and general. It is necessary also to look as it were into the future, in order to determine the probable result of the case, if no operation be practised; and if one be resorted to, what is likely to be the ultimate fate of the patient. Balancing these important questions in his mind, he should calmly decide in favour of that course that gives the greater prospect of good, recollecting the rule of Sanson, as modified by Dr. King,* “that amputation ought only to be performed when the danger and inconvenience to which it exposes the patient, are less than those of the disease treated otherwise.” Even when fully imbued with the knowledge of his profession, the surgeon will often find himself placed in a most responsible and delicate position, in which he will require the counsel of a professional friend; as where a large limb is the part involved, and there is hope that the operation may be avoided, as well as great danger that delay may render it impracticable or futile. It is not, perhaps, saying too much, when I aver, from the frequent opportunities which I have had of witnessing their performance, and the fair share that has fallen to my own lot, that from a combination of erroneous judgment and a mistaken motive of humanity, the performance of these operations is frequently deferred until their chances of success when practised have been considerably compromised.

PLACE OF ELECTION.

When the amputation of a limb is considered requisite, it be-

* Cyclop. Pract. Surg., art. Amputation.

comes necessary to decide at what point it should be practised. This has led to the distinction, by the French surgeons, of, 1, the *place of necessity* when there is no choice of site, there being but one spot where the operation can be performed at all without serious inconvenience; 2, the *place of election*, when there is a choice of several positions at which the limb may be amputated. But in truth, that should be considered the place of necessity which combines the best chance of the patient's recovery, and the formation of a sound and serviceable stump; yet while there exists such a difference of opinion among surgeons in reference to this subject, it will be found convenient to retain these terms.

INSTRUMENTS.

The instruments that have been used for this operation are very numerous. They may be classed under the following heads:—

1. *Those for arresting the circulation in the arteries.* These consist of the common tourniquet, the compressor of Dupuytren, and the garot of Morand.* Many surgeons, however, dispense with these instruments altogether, inasmuch as they dam up and cause a waste of the venous blood, and sometimes fetter the movements of the operator, and trust to pressure made on the great arterial trunk of the limb by the fingers of an experienced assistant. The possibility of an inadvertent relaxation of the force applied, and an unusual bifurcation of the main artery, often found in the arm, and in rare instances met with in the thigh,† are causes which render pressure with the finger less suited for general adoption than the use of the tourniquet. In certain instances, however, as in amputation at the top of the thigh and the shoulder, and in cases of children, it is employed in preference to any other means of stopping the circulation in the vessels.

2. *Of those for dividing the soft parts.*—These should consist of four amputating knives of different shapes and dimensions, and one or two common scalpels. Of the amputating knives, I prefer one, for the circular operation on large limbs, eight inches long in the blade, straight on the edge so as to cut from the heel to the point, and sufficiently thick on the back to be firm and resisting; the handle should be nearly as heavy as the blade and not too long, in order that it shall feel well in the hand and be readily manœuvred. A sharp-pointed knife, seven inches long in the blade, and double edged near the point, will be convenient for circular operation on the arm, and the formation of flaps in various positions, but especially from without inwards. Two narrow eatlings will be needed; one of which should be ten inches long, for the cutting of flaps from within outwards, and the disarticulation of the two great joints; and one five inches long for the division of parts in the interosseous spaces.

3. *Those for dividing the bone.*—These should consist of one large saw, resembling that of the joiner, widely set on the edge, for the section of the large bones; a smaller and finer one, either with a bow back or a simple straight blade, for the division of

* The English tourniquet may be seen applied at Pl. XLIII. The other instruments at Pl. VII.

† Sir C. Bell encountered the anomaly in the femoral in a case where he had performed the Hunterian operation for popliteal aneurism. The anomaly was revealed by the failure of the operation, and the death of the patient. Prof. Quain met with this division of the femoral, but once in near 1200 cases.

splinters and the smaller bones; a pair of cutting forceps, which may also be used for the latter purpose, and an ordinary pair of bone nippers for the snipping away of any splintered edges remaining after the section of the bone.

4. *Those for securing the vessels.*—These will consist of the dissecting or artery forceps for securing the large vessels,—to do which neatly two will be required; one for seizing the artery on the surface of the stump, and the second for separating it from the nerves and other surrounding parts, to facilitate the proper application of the ligature:—two tenacula for the raising of the lesser arteries, and a few suture needles, furnished with ligatures of different sizes, to make the mediate ligature of some of the smaller vessels after the manner of Paré, (see page 34,) when their orifices cannot be discovered, or their walls are so softened as not to bear the knot; scissors curved and straight; and a large linen compress, split for half its length into two or three strips, according as the part to be amputated is provided with one or two bones.

Dressing.—The apparatus required for the dressing of the stump, is nearly similar to that needed after other extensive operations: warm water and sponges, adhesive straps of various lengths, and a vessel containing boiling water, against the sides of which the straps are to be warmed; two or more small pieces of linen, in which to enclose the ends of the ligatures; lint, linen compresses, and two roller bandages each two or more yards in length. The Malta cross may if desired, be used to cover the stump; but the pad of charpie, tow, and even the cushion of down, formerly used with the object of soaking up the discharges, are now properly abandoned.

THE POSITION OF THE PATIENT, THE SURGEON, AND HIS ASSISTANTS.

The room where the operation is to be performed ought to be well lighted, and not far distant from where the patient is afterwards to be placed in bed. It is commonly the custom previous to subjecting the patient to the amputation of a large limb, or any other severe operation, to administer a full dose of opium, for the purpose of allaying excitement and diminishing the susceptibility to pain. This is not, however, universally practised. The bowels ought to have been thoroughly opened the day before the operation, so as to render their action unnecessary soon after, as well as to diminish the risk of constitutional irritation. When the patient has made up his mind to the operation, he should not be kept in suspense, but all the necessary preparations made as quickly as possible. If the operation is to be performed on the upper extremities, he may be seated on a chair; if on the lower, he is placed on a convenient table or bed, and the diseased extremity drawn aside so as to be easily accessible; but the position will vary more or less according to circumstances, and depends greatly upon the part which is to be removed. For the amputation of the smaller limbs but one or two assistants are required, the operator himself taking hold of the part to be removed with his left hand. In that of the larger limbs from four to six are necessary, some of which at least ought to be professional men, or at least well acquainted with all the particulars of the proceeding. One has to regulate the compression of the principal artery either with the tourniquet or with his fingers. If the tourniquet be chosen, it

ought not to be tightened till the operator is ready to begin. In cases where the artery cannot be felt from its being deeply covered by fat or enlarged lymphatic glands, where instead of one main branch the limb is abnormally supplied with several arterial trunks, and in places where no bone lies close to the vessel, the use of this instrument is positively indicated. The second assistant is to hold the limb with both hands above the place of amputation, to retract the skin and the divided muscles, and in general has to give the limb the most convenient direction for the operator to use the knife with freedom. The third assistant holds the limb below; his attention should be particularly directed to keep it fixed, and when the bone is being sawed through to prevent its becoming inclined either upwards or downwards, which might bind the saw or cause a splintering of the bone. It is recommended that he should kneel down, and as soon as the limb is separated remove it out of sight of the patient. A fourth hands successively the instruments to the operator; and one or two more are sometimes needed, especially in operations at the hip or shoulder joints, to assist in the ligature of the vessels, to aid in holding the patient, or assist in his restoration if he become faint. The position of the operator himself varies according to the part to be amputated; it depends also in a great measure upon the method he intends to follow, and will, therefore, be noticed in the description of the different processes.

METHODS OF OPERATION.

These are three in number:—the *circular*, the *flap*, and the *oval* or *oblique*; and are distinguished merely by the manner in which the soft parts are divided.

Circular method.—This is the oldest of all, and dates its origin from the time of Celsus—is apparently the most simple, and is still perhaps the one most frequently employed. The soft parts are here divided by circular incisions, carried completely round the limb; and to form a good stump, it is requisite in the first place that the knife be applied and carried round exactly at a right angle with the longitudinal axis of the bone; secondly, that the end of the incision fall straight on the point where the knife was first applied; and lastly, that the skin and muscles saved on the outside be sufficient to cover completely the end of the bone after the limb has been removed. According to the old method of Celsus, all the parts were divided at once down to the bone, dissected off from it for some distance, then retracted and the bone sawn through. But in this way it was found impossible to preserve skin and muscles enough to cover the stump; Mursinna, Rust and Dupuytren have, however, in certain cases attempted to revive the practice under some modifications. To attain the above-mentioned object with greater certainty, Cheselden and Petit practised a division of the soft parts by two separate circular incisions, the first dividing the skin and fat down to the aponeurosis; then retracting the skin and dividing the muscles somewhat higher up by a second circular cut. To this, B. Bell added the advice, previously given by Celsus, to dissect the muscles from the bone for some distance, so as to be able to use the saw higher up; and Louis, who had observed that the outer layer of the muscles contracted more during the operation than that attached to the bone, recommended the division of the super-

ficial layer at the time of the first incision through the skin, and that of the deeper muscles somewhat further up by a second cut. Dupuytren modified this proceeding by cutting through at once down to the bone; and then after the skin and superficial muscles had retracted, dividing by another circular incision the deeper seated layer again somewhat higher up.

The plan commonly followed now is ascribed to Desault, though his original proceeding has been somewhat modified. The first incision is carried through the skin and cellular tissue alone, at a distance proportioned to the thickness of the limb below the point at which the bone is to be cut. The operator holds the knife firmly in his hand, passes his arm under the limb so as to encircle it, and applies the edge of the knife, near the heel, perpendicularly upon that side of the limb which is directed towards him; and then, drawing the knife with a sufficient degree of pressure in a circle round it, brings up the heel perpendicularly at the place where the incision first began. Some surgeons divide first the upper part of the skin in a semicircle, and then the lower half in the same manner; and this undoubtedly is more easily done, though neither so sure, so neat, nor so rapid. That the skin may be retracted more readily, its cellular attachments to the fascia are now divided with the point of the amputating knife or a bistoury; if it cannot be retracted far enough, it will be better to turn it completely back like the cuff of a coat, as first recommended by Alanson. Besides this, some slit it open at the sides, or more unwisely remove a triangular piece out of it for the purpose of covering the stump more smoothly, since the retraction of the cicatrix and the action of the absorbents will remove the puckered angles left at the time of the first dressing. About half an inch below the retracted skin, the muscles are next cut through by a circular incision down to the bone. The cone, which projects in consequence of the deep-seated muscles having contracted or been drawn less far back than the superficial, is then divided again on a level with the superficial layer. With a smaller knife the operator then proceeds to dissect off the muscular fibres from the periosteum for about an inch further upwards, so that the divided bone may be afterwards imbedded, as it were, in the muscles; but care should be taken not to denude it farther than it is to be sawn off, as it would otherwise be liable to mortify, exfoliate, and seriously disturb the cure. The retractor is then placed around the bone. If there are two bones, as in the leg and forearm, the interosseous ligament has to be divided first, and each of the bones separately circumscribed with the knife. In the former case a retractor with two heads; in the latter one with three heads, will be necessary, the middle one being drawn through between the bones. After the parts are sufficiently retracted by the assistant, the operator places the thumb nail of his left hand upon the place where the bone is to be divided—close to the retractor—and then saws it through with light and steady motions of the instrument, perpendicularly to its axis. If the bone has been splintered from any incautious movement of the limb by the assistant, the splinters have to be removed with a pair of bone nippers or the knife; but if a neat section has been made, it is not good surgery to smooth off the edges with either of these instruments, which unnecessarily denudes the bone; the smoothing being far better accomplished by the action of the absorbents.

Another mode of performing the circular amputation of limbs

was recommended by Alanson, and after him extensively practised by Graefe. The object of this method is to give to the face of the stump the shape of a hollow cone, a result gained with greater certainty by the plan just described. The plan of Graefe, was to cut circularly through the muscles in an oblique direction upwards. As this is very difficult to accomplish with a straight knife, Graefe invented a particular instrument, which, however, no one else has used. This mode has justly become obsolete.

Flap method.—The origin of this method may properly be referred to Lowdham, an English surgeon, who employed it at London in 1679. Somewhat later, Verduin and Sabourin also practised amputation of the leg with a single flap. Ravaton and Vermale afterwards devised the method with two flaps, and applied it to the limbs generally. In some cases, particularly where the soft parts are very thick, as in the upper part of the thigh and arm, the flap method has undoubted advantages over the circular, and, as a general method, is preferred by many distinguished surgeons of the present day. The flaps are formed in two ways; 1, either from without inwards, after the manner of Langenbeck, by drawing the soft parts off from the bone at the part where the flap is to be formed, and then carrying the knife obliquely upwards as far as necessary, from the surface towards the bone: or, 2, (which is usually preferred,) from within outwards, when a long, narrow, sharp-pointed knife, either single or double edged, is first passed through the soft parts at the point of amputation, perpendicularly upon the bone, then carried round the semi-circumference of the bone, and made to pierce the skin of the opposite side; the edge being next brought with a sawing motion downwards and outwards to form the flap. The parts on the other side of the limb are to be divided by a semicircular incision, if it is intended to form but a single flap, which should then be long enough completely to cover the stump. If two flaps are formed, the second must be cut of equal length with the first, if it is intended that they should meet afterwards in the middle of the stump. That containing the large vessels is cut last. After the flaps are formed, the remaining soft parts around the bone are divided with a circular incision, the flaps turned back, and the bone sawed off as high as possible between them. One of the most important points in the application of this method, is to form the flaps sufficiently long; and, in making a calculation for this purpose, something should be added to the diameter of the limb, on account of the retraction which immediately takes place in the severed parts. Where it is possible to obtain from the soft parts two flaps of good dimensions, this method, as giving a larger cushion for the stump, and being better suited for union by first intention, is with good reason preferred by very many surgeons over the circular amputation. A perfectly good stump may, however, in most instances be formed by either process. In many cases, we resort to the flap as a matter of necessity, when, for instance, the skin and soft parts have been lacerated or otherwise destroyed higher up on one side of the limb than the other, and where, if we were compelled to employ the circular method, a greater portion of the extremity would have to be removed than is desirable.

The oblique or oval method.—This is in a manner a combination of both the circular and flap. Langenbeck first employed it for the removal of the metacarpal and metatarsal bones, Guthrie for the shoulder joint, and Scoutetten afterwards extended the practice

into a method for amputations in general. The incisions by this method are carried around the limb in a sloping direction, which is oblique in reference both to the longitudinal axis and the perpendicular diameter of the limb. All the soft parts are cut through at once, except they be very voluminous, when another incision in the same direction will be required. The flaps formed in this manner present an oval surface, angular at the starting point, but more rounded off at the far end, so as to resemble in shape a common kite, or the letter V, terminated by a rounded incision at the base. This method is decidedly preferable to the two preceding in operations through the joints, at the commissures of the fingers and toes. It is but seldom employed in operations through the continuity of the bones.

LIGATURE OF THE VESSELS AND DRESSING OF THE STUMP.

When the limb has been removed, the first thing to be done is to tie the vessels, and this is frequently more difficult to accomplish than the operation itself. Not only a minute anatomical knowledge of the situation of the larger branches between the parts forming the surface of the stump is required, but a steady hand, and much practice to find them in the interstices of the muscles into which they have retracted, and isolate them from the accompanying veins and nerves. The mode of accomplishing this object has been particularly detailed at page 35. The principal branches, the position of which is known, should be tied first, and then the place of the smaller and irregular may be the more readily detected by slackening the tourniquet, or relaxing the pressure of the finger upon the main trunk, to allow them to throw out a jet. One end of the ligature is to be cut off as soon as applied, in order to leave as little foreign matter as possible in the wound. After all the bleeding vessels are secured, the remaining ends of the ligatures are to be collected and brought straight out of the wound at the nearest and most convenient place, to interfere as little as possible with the union of the lips. For a long time suppuration was considered necessary to insure the life of the patient against the consequences arising from the loss of the larger limbs; but all English and American surgeons since the time of Hunter have considered that this opinion is founded merely on prejudice, and prefer to unite as much of the wound as possible by first intention. Its margins are therefore brought, immediately after the operation, in close contact. In circular amputations, when a pouch of skin is left at the bottom of the wound, it will be found useful to introduce a short piece of greased linen between the lips to prevent any damming up of the secretions. To effect union by first intention, great care and nicety is required. The surfaces of the divided parts, in the first place, ought to be smooth and even, and the care of the operator in this respect is of the utmost importance as regards the healing of the stump. If flaps have been formed, they are to be brought together in the way in which they will best fit. After the circular amputation, we may give to the line of the cicatrix any direction that is desired, and though the choice may occasionally be varied from the locality of the wound, a more or less perpendicular direction in general will be preferred as furnishing a free outlet to the purulent secretion, and more readily allowing the opposite sides of the incision, (which is a matter of much importance,) to come closely into contact. An assistant then

compresses the stump with both his hands, and at the same time holds it up, while the surgeon closes the wound nearly with adhesive straps passed from one side of the limb to the other, leaving small spaces between for the escape of the fluids. The adhesive straps may then be lightly covered with some lint, or fenestrated linen spread over with simple ointment, and a compress placed on the top. Two light compresses are then to be placed at the sides, and a roller applied over the stump, and for some distance up the extremity, to hold the dressings, and at the same time exert a good degree of compression upon the limb—sufficient to prevent the retraction and spasm of the muscles. Sutures are now never used, at least in circular amputation, as they cause unnecessary pain and irritation. In flap amputation they may, however, sometimes be found advantageous.

The most formidable accident liable to arise, either during or after the operation, is hemorrhage. If it occur during the operation, it is the consequence of an imperfect compression of the main trunk, or of an irregular distribution and dilatation of the branches, or may even arise from the veins, if these are in a varicose condition. In either case, if the bleeding is very profuse, the operation has to be terminated speedily, and the vessels tied as quickly as possible. If several torsion forceps are at hand, the principal branches may be seized and held until the operator is more at leisure to tie them. If the bleeding arise from the veins, it generally ceases spontaneously, or is readily controlled by the pressure of the dressing; the tying of these should if possible be avoided, though it may become necessary where a vein is diseased and has been obliquely opened in a flap amputation. Not unfrequently, the hemorrhage comes from the cavity of the bone, in consequence of a morbid development of the nutritious artery, and its having been divided close at its entrance in the bone. This is a troublesome incident. To tie the vessel is mostly impracticable. Plugging the orifice in the bone, tamponing the wound with lint, styptics, or even the hot iron in case of necessity, are the means to be employed in arresting the discharge. Secondary hemorrhage may also occur; and in the after treatment, ought to be most carefully guarded against. If it proceeds from any open vessels, either left untied, or which have been reopened from the ligature's having slipped or ulcerated off, they must be again secured, if the flow of blood cannot be arrested by compression and the use of refrigerants and styptics. If it be more of the nature of parenchymatous bleeding, it will prove troublesome, and must be managed as directed in Part First of this work.

If the disease is found to extend higher up than at first expected, the plan of operation has to be changed immediately, and a greater portion of the limb removed. Among the numerous occurrences which may delay or defeat the successful issue of the operation, are to be mentioned, fistulous and sinuous cavities around the stump, exfoliation and mortification of the bone, the formation of a conical stump, inflammation of the stump, and phlebitis. But all these the surgeon may usually guard against by judicious after treatment.

SPECIAL AMPUTATIONS.—UPPER EXTREMITY.

It has commonly been the practice of writers, to describe under separate divisions the amputation at the joints, and those in the

continuity of the bones. But inasmuch as these operations are practised for similar affections, and the processes for the two are in many respects analogous, it will be obviously proper as well as found more convenient for reference, to have them described together.

The surgical precept already referred to as of general application, that of amputating at the farthest possible point from the trunk, in order to save as much as we can of the limb, is of especial value in regard to the upper extremity. This will determine the order in which we shall take the operations up. And it may be well, also, to observe, in connection with this part of the subject, that such is the importance of preserving as entire as possible the upper extremity, that even the opponents of amputation at

the joints usually sacrifice their opinions in reference to the upper extremity, when by disarticulation they are enabled to preserve a greater length of the member.

1. OF THE HAND.

AMPUTATION OF THE PHALANGES. (PL. XXXIII.)

Surgical anatomy.—The anterior extremities of the first and second phalanges present an articular surface slightly concave in the middle, and bounded upon each side by condyloid projections, while the posterior extremities of the adjoining phalanges present

PLATE XXXIII.—AMPUTATIONS OF THE PHALANGES OF THE HAND.

(Fig. 1.) (A). AMPUTATION OF THE SECOND PHALANX OF THE FORE FINGER IN THE CONTINUITY OF THE BONE.

The soft parts have been divided circularly with the knife, and the skin retracted by two small strips of linen, which are crossed on the opposite side of the wound. A small saw-knife, edged upon the back, such as is frequently employed for the sake of convenience in these cases, is seen lying on the bone, after it has made a complete section of the tendinous structure. The instrument is to be reverted, and the bone divided with the serrated edge. An assistant draws the integument towards the palm with the band (*a*); the surgeon with the left hand supports the end of the finger to be removed.

(B). AMPUTATION THROUGH THE FIRST PHALANGEAL JOINT OF THE RING FINGER. (Process of *Lisfranc*. Flap on the palmar surface.)

The end of the finger is held in the left hand (*c*) of the surgeon, and the bistoury, which has been carried through the articulation, is about to divide the palmar flap, the surgeon favouring its action by luxating the first phalanx upwards.

(C). AMPUTATION AT THE FIRST PHALANGEAL JOINT OF THE THUMB. (*Circular operation*.)

The operation is represented at its completion. The dressing of the stump is shown at fig. 6.

(Fig. 2.) (D). AMPUTATION IN THE FIRST PHALANGEAL JOINT OF THE MIDDLE FINGER. (Double flap—palmar and dorsal. Modified operation of *Lisfranc*.)

d. Hand of an assistant, holding the other fingers out of the way.

e. Left hand of the surgeon, supporting the end of the finger. The palmar flap has been cut and drawn backwards, and the knife is seen passed through the joint, and about to separate the flap on the dorsal surface.

(E). AMPUTATION AT THE FIRST JOINT OF THE LITTLE FINGER BY A SINGLE DORSAL FLAP. (*Process of Lisfranc*.)

The drawing represents the parts at the conclusion of the operation.

(Fig. 3.) (F). AMPUTATION AT THE METACARPO-PHALANGEAL JOINTS, BY THE OVAL METHOD. (*Process of Scoutetten*.)

The hand of an assistant (*f*) sustains that of the patient. At F the surgeon with the left hand (*g*) grasps the end of the middle finger, while with the right he carries the bistoury round the articulation in an oval direction. The moment of the operation shown, is when the knife, after having been carried round so as to cut the palmar fold of skin, is being brought up heel foremost to join the dorsal incision near its place of commencement. At

Fig 1

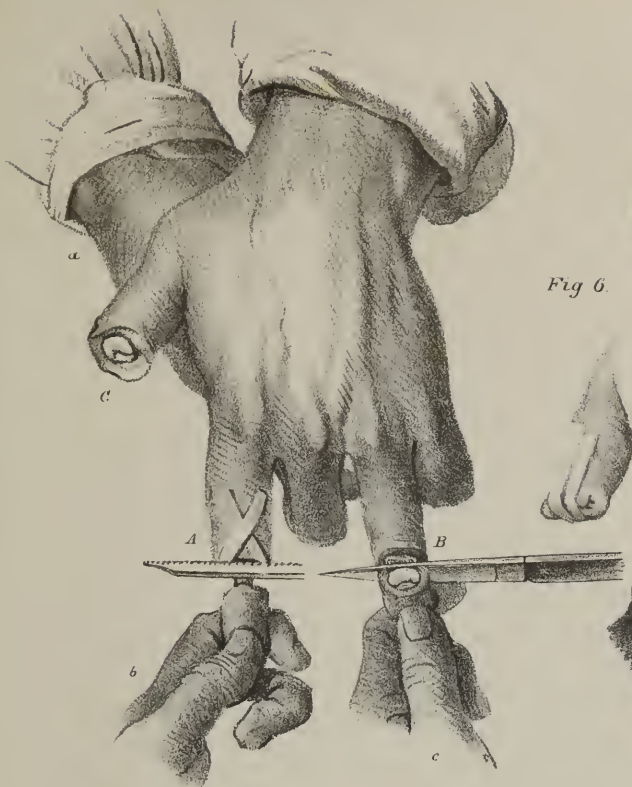


Fig 5



Fig 6



Fig 3

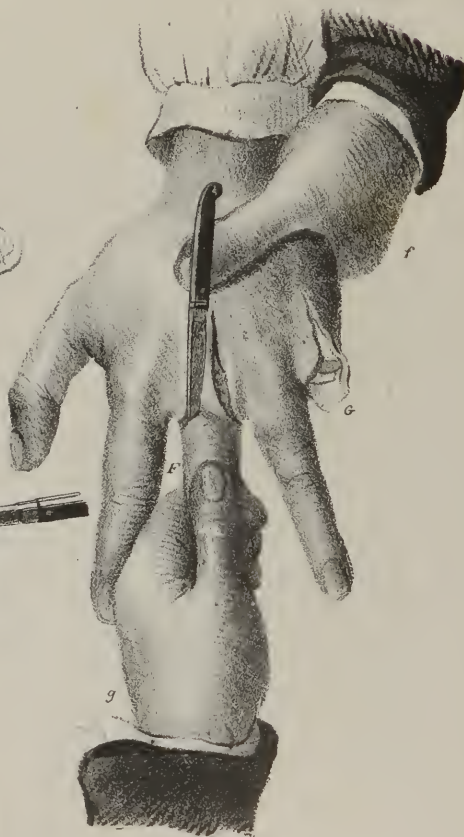


Fig 2

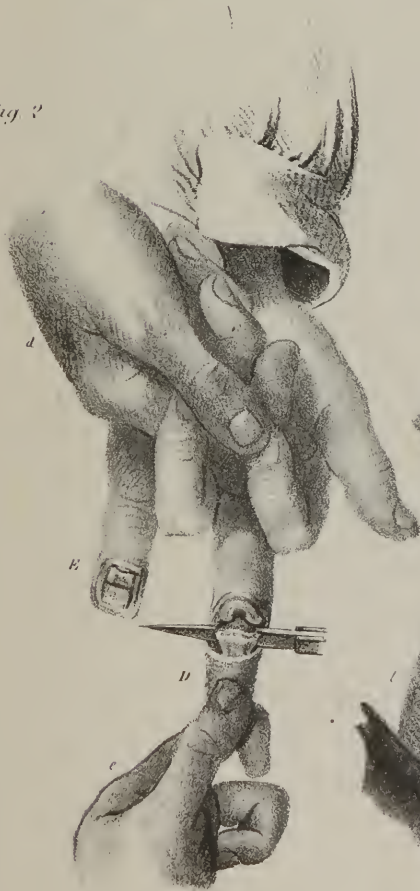
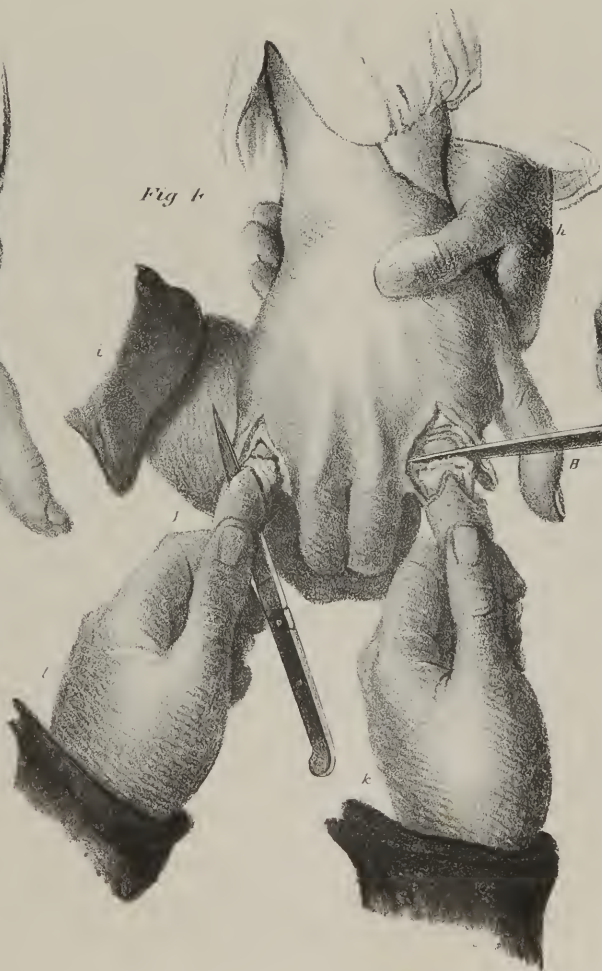


Fig 4



a conformation exactly the reverse. In this way a true hinge joint is formed, with a reciprocal interlocking of the opposing surfaces. Two strong lateral ligaments connect the bones, which must be first divided in the attempt at disarticulation, before a bistoury can be passed through the joint. The back of the phalanges is rounded, covered with the expansion of the extensor tendon, which supplies the place of ligament on that surface of the joint, and is overlaid by thin and movable integument. On the flattened palmar surface of the fingers, pass the two flexor tendons, one of which is inserted into the base of the second, and the other into that of the third phalanx. Between them and the joint, there is a layer of fibro-cartilaginous matter, which forms the palmar ligament; and around them, in order to confine them near the bone, is the vaginal or sheath-like ligament, the inner surface of which, as well as the tendons themselves, are lined by a double reflected synovial membrane, more or less connected with the great synovial sheaths in the palm of the hand, and forming altogether so extensive a surface as to make their inflammation a subject of serious importance. On the palmar face, the skin is thick, as well as the subcutaneous cellular tissue in which run the arteries and nerves. From this surface the flap must be principally obtained for the purpose of covering the stump.

The arteries do not require to be tied, the bleeding stopping spontaneously, or being readily arrested by the pressure of the dressing. If the two lower phalanges are removed, it might be supposed that the flexor tendons would not act upon the remaining one; but experience has shown that they become firmly blended with the parts on the face of the stump or the surface of the bone adjoining. An assistant is to support the hand of the patient, keep the other fingers bent in the palm, and present the one to be operated on, extended to the surgeon. The amputation may be done either at the joints or in the continuity of the bone.

The exact position of the joints is shown by the flexion of the fingers; the prominent point in the flexed position belonging to the

bone behind. It is also, and still better, indicated by the dorsal and palmar creases; in the former, which are numerous and concentric over the back of each articulation, we usually find a deep central one which corresponds to the line of the joint. But the palmar folds are the surer guides. There are two of these at the junction of the first with the second phalanx; the inferior or distal one will be found opposite the joint. The union of the second with the last phalanx, is two lines below the single palmar crease.

AMPUTATION AT THE TWO PHALANGEAL JOINTS.

(PL. XXXIII. FIG. 1 and 2.)

This may be done by the circular method, or by the flap; the latter is, however, usually preferred.

Circular operation.—The finger is to be held extended while the surgeon divides the skin circularly three or four lines in front of the joint. It is then to be well flexed by an assistant, who at the same time draws back the divided skin; the surgeon next divides the extensor tendon just in front of the joint, and carrying the knife along with a slight sawing motion, opens the back of the articulation, passes the blade through the cavity, rocks the loosened phalanx from side to side as he divides the lateral ligaments, and finishes by cutting square through the flexor tendons.

Dressing.—The edges of the skin are then to be brought in a line from side to side over the head of the phalanx, and secured by two strips of adhesive plaster, and a few turns of a small roller.

Flap operation.—There are several processes by the flap. The best are those of Lisfranc, slightly modified by giving more length to the dorsal skin.

1st Process of Lisfranc. (Pl. XXXIII. fig. 1.)—An assistant retracts the skin from the place of operation towards the palm. The surgeon, holding the phalanx to be removed with its palmar face downwards, between the thumb and finger, flexes it at an

G the same kind of operation, after its termination, is shown upon the little finger. The wound is to be closed with a couple of narrow adhesive straps.

(Fig. 4.) FLAP AMPUTATION AT THE METACARPO-PHALANGEAL JOINTS.

The two hands of an assistant (*h, i*) are seen applied; the one to sustain the member, and the other to draw the fingers into the palm of the hand; while the left hand of the surgeon (*k, l*) grasps the end of the finger to be removed in each of the processes shown in this drawing.

At B, the amputation of the fore finger is shown according to the process of Petit. The stage of the operation shown, is when, after having formed the two lateral flaps, the knife is carried through the joint to finish the disarticulation. On the little finger is seen the double flap operation of Lisfranc. The knife has been carried up on the radial side of the joint, so as to form one flap; has opened and passed through the joint, and is seen descending on the other side so as to cut the second flap and at the same time detach the finger.

(Fig. 5.) AMPUTATION OF THE FOUR FINGERS TOGETHER, AT THE METACARPO-PHALANGEAL ARTICULATIONS.

The hands of an assistant (*m, n*) are applied so as to secure that of the patient, and present its dorsal surface upwards. The left hand (*o*) of the surgeon grasps the ends of the fingers. The period of the operation shown, is that when the knife, after having cut the skin and tendons on the dorsal surface, and opened all the articulations, is employed to finish the section on the palmar face.

angle of 45 degrees, and draws a straight, narrow bistoury from heel to point half a line in front of the projection formed by the head of the phalanx, so as to divide the skin and extensor tendon. The handle of the instrument is then raised and inclined towards the surgeon, so as to bear the point downwards and divide the left lateral ligament before entering the joint; the right is next divided by carrying the handle downwards, inclined from him. The joint being now opened, the phalanx is to be luxated backwards, and the bistoury carried round its head so as to cut a flap on the palmar surface sufficiently large to cover all the face of the wound.

Remarks.—The process is neat and rapid. But in operations on the living subject, I find that a better stump is formed by making the dorsal incision of a semilunar shape, with the convexity in front of the joint. It is frequently difficult to avoid notching the flap as the knife is turned round the head of the bone. By cutting previously one side of the flap, and rocking the phalanx sideways, this difficulty may be obviated. It is also better to imitate the process of Delpêch, and measure the palmar flap on the face of the stump before we cut it from the bone. In cases of necessity, the flap for covering the end of the bone may be taken either from the back or sides of the joint.

2d Process of Lisfranc. (Pl. XXXIII. fig. 2.)—The hand is held with the palm upwards, and all the fingers closed but the one to be operated on. The surgeon applies his left thumb upon the end of this finger, and his middle finger behind the articulation to be opened. Placing his bistoury flatwise, and so as to be supported on the pulp of his middle finger, he passes the point through, shaving the bone, below the crease already described as indicating the palmar line of the joint. The handle, as the bistoury enters, should be a little depressed: it is then to be brought horizontal, and lastly elevated as the point passes out at the other side, so as to give the largest breadth possible to the base of the flap. The bistoury is next to be pushed forward up to the heel, and the flap finished as it is withdrawn, cutting from heel to point. The bistoury is now to be carried to the base of the flap, so as to divide the anterior portion of the capsule and the two lateral ligaments, and finish by cutting the skin and tendon on the dorsum level with the joint.

Remarks.—This second process of Lisfranc is more frequently employed than the first; it does not, however, appear to me to possess any advantages over the first when this is practised with the modifications mentioned above.

Dressing.—This is very simple. The flap is to be fastened over the surface of the stump with adhesive plaster, and the finger surrounded with a few turns of a roller;—the arm to be carried in a sling.

AMPUTATION OF THE FINGERS IN CONTINUITY OR THROUGH THE PHALANXES. (PL. XXXIII. FIG. 1.)

This is to be preferred to disarticulation, when it can be practised, so as to preserve a greater length to the stump of the fingers. The instruments required, in addition to the bistoury, will be a small, fine saw, or the cutting forceps of Liston, for dividing the bone. The old practice of cutting the bone with a chisel has, even in modern times, been employed by Graefe.

The *circular method* is the one most generally used in this amputation, and is to be employed precisely as described for disarticulation, at page 139, with the exception of the division of the bone with the saw or forceps.

The *flap operation* employed in this amputation, is also, with the same exception, similar to the process of Lisfranc last described. Some surgeons, however, prefer to cut the flap from without inwards towards the bone, rather than to raise it by a previous puncture with the bistoury.

AMPUTATION IN THE METACARPO-PHALANGEAL ARTICULATION. (PL. XXXIII. FIG. 3 AND 4.)

Surgical anatomy.—The construction of the knuckle joint is that of a ball and socket; the ball is formed by the prominent end of the metacarpal or knuckle bone, immediately in front of which lies the joint. The capsular ligament is loose, so as to render the situation of the joint visible in a *healthy state*, by drawing on the finger. When the fingers are extended, the line of articulation will be found nearly an inch above the interdigital web or commissure, and a very little below the deep transverse line of the palm formed by the flexion of the fingers.

Amputation of a single finger.—The only methods suited to this operation are the flap and the oval.

Process of Lisfranc. (Pl. XXXIII. fig. 4.)—This is but a modification of that of Ledran. The hand placed in pronation, and the adjoining fingers separated by an assistant, the operator having ascertained, by the rules above described, or by moving it, the exact position of the joint, seizes the extremity of the digit to be removed with the thumb and finger of the left hand, and bends it at the metacarpo-phalangeal joint at an angle of 45 degrees. A narrow, straight, long-bladed bistoury, held in the third position, is laid nearly over the middle of the knuckle bone, so as to divide by pressure and a slight sawing motion all the parts through to the bone, from a quarter of an inch above the joint, down to the commissure of the finger on the surface of the palm; the knife being held as we reach the commissure as if we were about to cut directly across the head of the phalanx. The handle is now to be depressed towards the palm, to make a neat section of the end of the flap, and the blade, held nearly vertically, run up in a sort of sawing movement closely in contact with the bone, so as to divide the soft parts on the palm opposite to the point at which the incision was commenced on the back. The instrument without being withdrawn is then turned with its cutting edge directly upon the joint, which it opens by the same sawing motion, and should be so lightly held as to slip over the inequality of the bones and fall into the joint. An assistant at the same time draws up the skin on the back of the wrist, to keep it from being nicked by the knife as it divides the flexor and extensor tendons in its passage across the joint; the surgeon at the same moment pulls upon the finger and carries it in a direction opposite to that of the knife. The first flap is now formed, and the second is completed and the finger detached by bringing the knife down on the opposite side of the finger, which it shaves from the joint to the commissure.

By this process the digital arteries will only have been divided after their bifurcation, and usually soon cease to bleed. If the hemorrhage continues they are to be tied. If this operation be

performed for the removal of the index or the little finger, it is necessary, on account of its greater tendency to retraction, to cut the marginal flap considerably the longer of the two, the appropriate length of which may readily be ascertained by measuring it over the surface of the joint before detaching it from the phalanx. This process is rapid and showy. But it is attended by a deep incision into the sensitive palm, and is apt to be followed by a painful cicatrix. It has, in fact, in reference to its application to the living subject, but little to recommend it over the older processes of Sharp and Petit.

Sharp made a circular incision at the level of the commissure, from which two lateral ones were extended upwards so as to form a dorsal and palmar flap.

Petit cut two lateral flaps, the extremities of which met on the back over the metacarpal bone, and on the palm just above the commissure.

But the method of all others best suited for the removal of a finger at this joint, is the *oval method* or process of *Scoutetten*. (Pl. XXXIII. fig. 3.) The finger held in the manner indicated in the method of *Lisfranc*, the surgeon takes the bistoury in the right or left hand, according to the limb on which he acts, and lays it so that the point shall rest a quarter of an inch above or beyond the dorsal face of the joint. Then, pressing it down to the bone, he makes an incision obliquely downwards to the commissure of the finger of the same side; next raising the finger as far as possible, he sweeps it round the palmar face to the commissure of the other side; and now, flexing the finger, draws it rapidly up from heel to point, so as to make a second oblique incision terminating on the first, two lines below its commencement, the bistoury dividing the skin completely in its course. He now cuts the extensor tendon and opens the back of the joint, divides the lateral ligaments, luxates the phalanx backwards, and carrying the knife below the head, separates the finger from all its remaining connections. An oval or sort of V shaped wound is left. The division of the soft parts is but little extensive, and the palm is wholly uninjured. In removing the index or little finger, the bistoury must be carried so as to cut a flap longer on the border of the hand.

Dressing.—This is very simple. The arteries rarely require to be tied. The fingers are merely to be brought together (which will suffice to close the wound) and secured with a roller bandage. The hand is to be carried in a sling. For the index or little finger, adhesive straps must, however, be used to approximate the edges of the incision. There is no fear in this operation of leaving too much integument, as this will thicken and contract to the requisite extent during the progress of cicatrization.

Dupuytren proposes to excise in addition the head of the metacarpal bone, for the purpose of allowing the adjoining fingers to come nearer together. But experience has shown that this is a measure wholly unnecessary.

AMPUTATION OF THE FOUR FINGERS TOGETHER.

This is but a modification of the process for the removal of a single finger, applied to all the fingers of the hand.

The process of *Lisfranc*, (Pl. XXXIII. fig. 5,) to whom we are indebted for the establishment of this operation, is as follows.

The surgeon grasps the fingers in his left hand, with his thumb and fore finger applied to the opposite ends of the range of joints; an assistant at the same time drawing up the skin of the back of the hand. He then commences his incision at one margin, and carries it just over the base of the phalanges, a quarter of an inch in front of the metacarpal bones, laying bare the extensor tendons in its course. The retraction of the skin by the assistant opens the wound. The skin is then loosened with the knife, till the joints are exposed, over which the extensor tendons are to be cut. The operator then divides the lateral and palmar ligaments of each joint in succession; and gliding the knife under the base of the phalanges, shaves their inferior surface, and forms the palmar flap by cutting along the fold which separates the fingers from the palm.

Circular method. Process of Cornuau. (Pl. XXXIV. fig. 1.) —The surgeon, grasping the fingers with the palmar surface upwards, makes at one cut a semicircular incision, convex in front, which crosses the commissural line of the fingers, dividing the skin, aponeurosis, flexor tendons and vessels, so as to expose the heads of the metacarpal bones. He then, without loosening his hold, turns the hand in pronation, and makes a similar incision on the back, continuous at its extremity with the former, which divides the skin and extensor tendons. He next luxates the phalanges backwards, and removes them, by cutting across in succession the lateral and anterior ligaments of each joint. The dorsal incision should pass across about a quarter of an inch in front of the head of the metacarpal bones, in order to leave sufficient integument for the dorsal flap. This circular process has been applied to the removal of a single finger, but is better suited to the operation just described, in which it has a decided superiority over that of *Lisfranc* in respect to the greater regularity of the palmar flap.

The eight digital arteries are divided by either process. When these require to be tied, which is very unusual, the ends of the ligatures are to be brought out at the ulnar and radial margins of the wound. The dorsal and palmar flaps are to be drawn together by straps of adhesive plaster.

There is some danger to apprehend, in case there be developed any inflammation of the synovial sheaths of the tendons which extend up into the palm. The risk of this occurrence is to be obviated as much as possible by a compressing bandage about the palm, an elevated position of the limb, and a constant irrigation of the parts with a stream of cold water. But if it follow, and the hand becomes painful and swells to a considerable extent, free and deep scarification must be employed, in order to stop the progress of the inflammation, which might involve the risk of a second amputation, or even the loss of life.

AMPUTATION IN THE CONTINUITY OF THE METACARPAL BONES.

Whenever the nature of the lesion allows the choice, it is better to amputate through the metacarpal bones than at their articulations with the wrist. If we amputate the four metacarpal bones of the fingers together, they may be sawed directly across. But if either one be removed separately, it is better to divide it obliquely so as to leave a beveled surface, making the bevel at the

expense of the radial side for the third and fourth, and of the ulnar for the first and second.

The last four metacarpal bones may be removed together either by the circular method or the flap.

Circular method. (Pl. XXXIV. figs. 1, 2, 3.)—The wrist is to be held by one assistant, (who at the same time draws upon the skin,) the fingers supported by another, and the thumb well separated from the palm. The operator divides the integuments circularly an inch at least below the point at which he wishes to cut the bone. The divided integuments are to be further drawn upwards for half an inch by the assistant, who continues his traction on the skin, while the surgeon loosens it with his knife. The tendons are then to be divided on a level with the edge of the skin, and the interosseal muscles cut by a narrow knife insinuated between the bones. The soft parts are next to be drawn back by a five-tailed compress, the three middle strips of which

are passed between the bones. The bones are then to be divided either with the saw or the cutting forceps.

The arteries are to be twisted or tied, and the wound closed with adhesive straps passed from the palm to the back.

By a double flap.—Velpeau cuts a dorsal flap convex in front, which he dissects up. He then passes his knife from one angle of the incision to the other, along the front surface of the metacarpal bones, so as to cut a palmar flap.

By a single flap.—Onsenoort cuts a flap on the palmar surface only, either by dissection downwards, or from within outwards; plunging the knife in the latter case along the face of the bones, and cutting obliquely outwards into the palm. In either of these modes, care must be taken to leave the margins of the flap a little more prominent than the middle, in order that it may be made to cover completely the ends of the second and last metacarpal bones.

PLATE XXXIV.—AMPUTATIONS OF THE METACARPUS.

Figs. 1, 2, 3.—Circular amputation in the continuity of the four metacarpal bones of the fingers of the right side, (Process of Cornuau.)

(Fig. 1.) SECTION OF THE SOFT PARTS ON THE PALMAR SURFACE.

- a. Left hand of an assistant sustaining the palm.
- b. Right hand of the same assistant holding the thumb out of the way of the knife.
- c. Left hand of the surgeon grasping the fingers while he divides with the knife (d) the flesh and tendons of the palm.

(Fig. 2.) DIVISION OF THE METACARPAL BONES WITH THE SAW FROM THEIR DORSAL SURFACE.

The circular section of all the soft parts having been completed, and the interosseus muscles divided with a narrow knife, five narrow bands have been employed (three of which pass through the interosseus spaces) in order to draw back the divided tissues and admit of the application of the saw (h).

- e, f. The two hands of an assistant supporting that of the patient.
- g. The left hand of the surgeon supporting the fingers.

Fig. 3.—Adjustment of the flaps over the divided ends of the bones, after the preceding operation, by the aid of four strips of adhesive plaster.

The interosseous and digital arteries have been twisted instead of tied, hence no ligature threads appear in the wound.

(Fig. 4.) AMPUTATION THROUGH THE METACARPO-CARPAL JOINT OF THE LEFT HAND.

The operation is shown at the moment when the surgeon is about to complete it by cutting the palmar flap. The ends of the metacarpal and of the lower range of carpal bones appear in the wound.

- i. Hand of an assistant sustaining the wrist of the patient.
- j. Left hand of the surgeon supporting the fingers of the patient, while with the knife (k) in the other, he finishes the operation.

(Fig. 5.) SKELETON OF THE HAND SHOWN FOR THE PURPOSE OF ILLUSTRATING THE ARTICULATION OF THE DIFFERENT JOINTS.

- a, b. The two ranges of carpal bones.
- c. Five metacarpal bones.
- d. First range of phalanges.
- e, f. Second and third ranges.

Fig 1



Fig 2



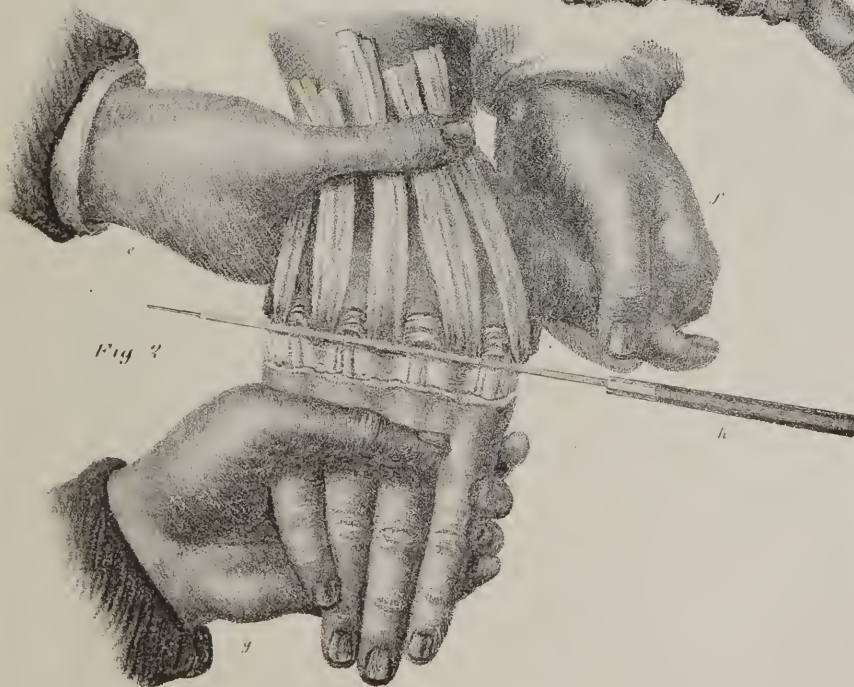
Fig 3



Fig 5



Fig 4



AMPUTATION OF THE METACARPAL BONES SEPARATELY IN THEIR CONTINUITY.

Of the metacarpal bone of the thumb.—The anterior extremity of this bone may be very readily removed by the common circular process described at page 135, dividing the skin at the level of the metacarpo-phalangeal joint. If it be necessary to remove a larger portion, the oval process will be found preferable to any other. The apex of the oval or V shaped incision should in this case rest upon the radial side of the metacarpal bone, and its base circumscribe the palmar fold of the thumb. The soft parts are then to be loosened on the palmar face of the bone, and the latter divided obliquely across from above downwards and inwards with the saw.

Of the second or fifth metacarpal bone. Either of these may be amputated in its course in a similar manner by the oval process, with the exception that the bone should be divided obliquely in a direction opposite to that recommended for the thumb.

For the removal of the third and fourth metacarpal bones, (Pl. XXXVI. fig. 1), the oval process may also be applied with advantage. I have twice employed it with success, and the division of the bone, which is the more difficult part of the operation, was readily effected with the cutting forceps of Liston. This process enables us to avoid the division of the vessels, nerves and tendons, in the palm of the hand,—an object of very serious consideration.

The following, however, is the process more generally recommended. The hand held in pronation is to be transfixed from the dorsal to the palmar face with a narrow, sharp pointed bistoury, which is to enter just above the diseased part, and shave down the sides of the bone till it cuts through at the corresponding commissure of the fingers. The skin on the *back* of the bone to be amputated, is to be drawn as far as possible under the edge of the knife, so that the surface of the bone may be exposed after the incision. The skin and soft parts are then to be drawn to the opposite side away from the untouched surface of the bone; along this surface the bistoury is again to be entered, falling into the former line of incision, so as to separate the bone from its remaining connections without any new division of the skin, except at the place of the commissure on the other side of the finger. A short V shaped wound is thus formed, with its base towards the phalanges. A small piece of wood, card, or a compress, is to be introduced on one side of the finger, and a narrow saw at the other, with which the bone is to be divided obliquely across, and the finger with the anterior part of the bone removed. If the palmar arches are divided or the digital arteries before their *subdivision*, they will require to be tied; but if the vessels are only cut near the commissures, simple coaptation of the sides of the wound, and gentle compression with a roller, will alone suffice to arrest the bleeding.

AMPUTATIONS IN THE METACARPO-CARPAL JOINTS.

The five bones of the metacarpus may be disarticulated in a mass from the inferior row of carpal bones, or any one may be removed by itself. But it is seldom that any but the two first and the fifth require to be taken away separately.

AT THE METACARPO-CARPAL JOINT OF THE THUMB.

Surgical anatomy.—The superior extremity of the first metacarpal bone is slightly convex and triangular in shape, and is attached by a loose capsule in its articulation with the trapezium, where it is separated only by a space of one or two lines from the base of the metacarpal bone of the fore finger, which rests against the trapezoides and the inner face of the trapezium. On the back surface, the bone of the thumb is coated only by the skin and extensor tendon; on its palmar surface, it is covered thickly by the mass of muscles. Its junction with the trapezium may in the healthy state of the joint be readily ascertained by pressing the thumb towards the indicator and running a finger back along its dorsal edge, till we feel the tubercle formed by its head, immediately behind which is the joint. More or less motion may also be felt at this joint in flexing and extending the metacarpal bone. Care must be observed, however, not to confound the tubercle of the metacarpal bone with the projection of the scaphoid, which will be found nearer the wrist. In cases where there is so much tumefaction as to completely mask the joint, its position will be found to correspond very nearly with a point an inch below the styloid process of the radius. The line of articulation between the trapezium and metacarpal bone, along which the knife is to pass, is directed obliquely downwards and inwards toward the root of the little finger. The radial artery dips down into the palm between the bases of the metacarpal bones of the thumb and index finger, and is sometimes divided in the operation.

Remarks.—The great object of the operation is to fill up well with a flap the space from which the bone is removed, and avoid a cicatrix in the palm, which is apt subsequently to become painful upon pressure. These results are much better obtained by the oval method than the flap; to the former, therefore, I give the preference.

Oval method. (Pl. XXXV. fig. 1).—In operating on the right side, the hand should be placed in pronation, and the incision commenced on the radial border a line or two above the joint. For the left, on the contrary, the hand is to be placed in supination. The wrist supported and the fingers abducted by an assistant, the surgeon, taking hold of the point of the thumb, carries a sweeping incision with a long straight bistoury over the back of the metacarpal bone, down to the line which indicates the junction of the first phalanx with the palm; turns his knife round this line so as to form two-thirds of a circle, dividing all the parts as deeply as possible, and carries another incision up to the point at which he started, forming with the two an angle of about thirty degrees. Detaching rapidly the covering from the back of the bone, the surgeon divides the extensor tendons at the angle of the wound, opens the dorsal surface of the joint, depresses the lower end of the bone, and completes the division of the ligaments with the point of the bistoury; the blade of the knife is then to be passed through the joint behind the bone, so as to detach it completely by shaving its palmar face down to the base of the oval.

In order to prevent the liability to projection of the end of the trapezium through the back of the wound, Malgaigne has proposed to modify the operation by first making a linear vertical incision over the back of the joint, and beginning the two incisions to form the oval half an inch below the joint.

Flap operation. (Pl. XXXV. fig. 2. *Common process.*)—

The hand held as above described, and an assistant drawing the integuments to the radial border of the thumb to give as great dimensions as possible to the flap, the bistoury is placed vertically at the angle of the commissure between the thumb and the fore finger, and carried by the surgeon up at once to the metacarpo-carpal joint, (where it is arrested by the internal projection of the trapezium,) shaving the whole ulnar side of the bone in its course. Arrived at this point, the edge of the knife is to be turned outwards towards the bone, in order to prevent its passing between the trapezium and the second metacarpal bone. With a sawing motion, it now passes into the joint. The surgeon next luxates the bone backwards by inclining forwards its ulnar edge, and draws upon it so as to stretch the capsule, in order that he may carry the bistoury round the convex head of the bone. The operation is then completed by shaving downwards the radial edge of the bone, cutting out a little beyond the metacarpo-phalangeal joint, in order to obtain a flap sufficiently long to cover the wound. To form the flap as large and fleshy as possible, it is well in making the first incision, to incline the handle of the bistoury toward the little finger.

The dressing, in either mode of operation, is very simple. The blood-vessels are to be tied, or well twisted, and the wound closed by adhesive straps, supported by a few turns of a roller.

OF THE METACARPAL BONE OF THE LITTLE FINGER.

Surgical anatomy.—The internal border of the fifth metacarpal bone does not form the margin of the hand. It is overlapped by the mass of muscles, which renders easy the formation of a lateral flap. The oval method is, however, in this, as in the operation last described, the preferable method. By carrying the finger along the edge of the metacarpal bone, we feel a prominent tubercle at its posterior extremity. Immediately behind this is the joint, (marked by a little depression,) by which it is articulated with the unciform bone. The outline of the articulation is somewhat curved, but is found nearly in the direction of a line drawn from the ulnar side of the joint to the middle of the second metacarpal bone. It forms also another small articulation, by a lateral facet which meets with another on the adjoining metacarpal bone.

Oval method.—This process for the disarticulation of the fifth metacarpal bone, is so similar to the first, that it needs to be but briefly described. The hand turned prone, and the fingers conveniently secured, the oval incision is to be commenced a line or two above the joint, brought around the commissure of the finger, and carried back again to the starting point, so as to form there an acute angle. The bone is then to be loosened from the soft parts, or its sides disarticulated from the unciform bone, and separated by a sweep of the bistoury on its palmar face.

PLATE XXXV.—AMPUTATIONS THROUGH THE METACARPO-CARPAL JOINTS.

(Fig. 1.) OVAL AMPUTATION THROUGH THE CARPO-METACARPAL JOINT OF THE THUMB OF THE RIGHT HAND.

The incision of the skin and muscles having been completed, the operation is shown as the surgeon is about to complete the disarticulation of the bone.

a, b. Hands of an assistant sustaining that of the patient.

c. Left hand of the surgeon sustaining the thumb, while he cuts the ligaments of the joint with the knife (*d*) in his right.

(Fig. 2.) FLAP AMPUTATION OF THE THUMB.

The bistoury (*h*) has been passed up on the ulnar side of the metacarpal bone, carried through the joint, and is brought down on the opposite side of the bone so as to form the flap.

e, f. Hands of an assistant.

g. Left hand of the surgeon.

(Fig. 3.) AMPUTATION THROUGH THE METACARPO-CARPALJOINT OF THE LITTLE FINGER. (Process of Lisfranc.)

The internal or palmar flap having been cut by puncture, or dissection, from the ulnar border of the hand, the knife is shown in the act of being passed into the joint.

i. Hand of an assistant.

l. Left hand of the surgeon grasping the finger to be removed, while he employs the knife with his right hand (*m*).

(Fig. 4.) AMPUTATION OF THE THIRD METACARPAL BONE.

The bone has been isolated by two lateral incisions, forming a V with the base towards the fingers. The knife (*a*) is shown as applied to complete the section of its ligamentous attachments.

n. Left hand of an assistant.

p. Left hand of the surgeon.

Fig 4.

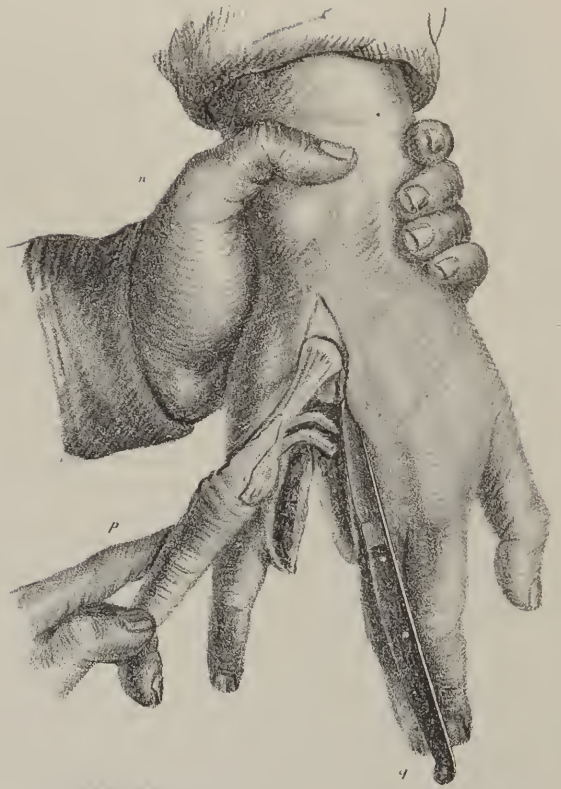


Fig 2.



Fig 1.



Fig 3.



Flap operation. (Process of Lisfranc.)—The hand is to be pronated. An assistant, or the surgeon himself with the left hand, draws the soft parts on the back and palm to the ulnar side, so as to allow the formation of as large and fleshy a flap as possible. The bistoury is passed from the back to the palm, perpendicularly through, on the inner side of the bone, exactly opposite the metacarpo-carpal joint, and is carried downwards, shaving the ulnar edge of the bone, so as to finish the flap a little below the commissure with the adjoining finger. The flap is then to be drawn upwards by an assistant, and the bistoury carried along so as to free the radial side of the bone. This may be done by drawing away the little finger from the one next to it, and cutting from the commissure upwards—or by carrying the integuments and extensor tendon towards the thumb, passing the knife between them and the bone, and cutting from above downwards to the commissure, between the ring and the little finger. The lateral ligaments are then to be cut, and the joint opened on the back or palm; the bone is then to be removed by cutting the interosseous ligament, which will be facilitated by rocking the bone at the same time a little outwards.

Palmer flap. (Pl. XXXV. fig. 3.)—This bone may also readily be removed by a palmer flap formed by dissection, as shown in the drawing. The oval method will, however, of all, be found the most appropriate.

OF THE METACARPAL BONES OF THE SECOND, THIRD, AND FOURTH FINGERS, AT THEIR JUNCTION WITH THE CARPUS.

The flap and oval methods have both been employed for the separate removal of these bones; and the processes are nearly the same as those for the removal of the first and fifth metacarpal. The chief embarrassment in these operations consists in the disarticulation, and arises partly from the form and number of the articular surfaces, and partly from the difficulty of attacking the joints upon their sides.

The second metacarpal, the removal of which is most difficult, forms a triple articulation—a sort of mortise and tenon joint—the middle part of its base uniting with the trapezoid bone; and the two projecting processes at its side uniting one on the radial side with the trapezium, and the other on the ulnar with the os magnum and the third metacarpal. These articular surfaces are all connected by ligaments, and a strong interosseous ligament unites the second and third metacarpal bones. But the key of this compound joint is an anterior or palmar ligament, fastening the process on the inner side of the head of the bone to the os magnum and the third metacarpal, without the previous division of which, disarticulation is almost impossible. We may mark out the line of articulation as follows:—carry the finger along the radial margin of the second metacarpal bone, till it is arrested by a prominence. This is formed by the head of that bone, and immediately behind it is the inner side of the joint, distant about an inch and a quarter from the styloid process of the radius.

The third metacarpal forms a single line of articulation obliquely downwards and inwards. That of the fourth metacarpal is nearly transverse. From the size of the vessels likely to be divided, a tourniquet should be applied to the arm; or what is more convenient, pressure made by an assistant on the radial and ulnar arteries.

Oval method.—The hand is to be placed in pronation, and the bistoury, starting from a point a little above the middle of the articulation, is to be carried obliquely downwards and across the bone to one of the commissures, thence round the digito-palmar groove, and up again over the dorsum to the place of commencement, so as to form an oval-shaped incision with an acute angle above. The lips of the wound are now to be separated by an assistant; the surgeon cuts with the front of the bistoury the dorsal and interosseous ligaments, luxates the head of the bone by pressing its anterior extremity into the palm, and, gliding the knife under its palmar face, detaches the bone in its whole extent.

In disarticulating the second metacarpal, it is necessary in dividing the ligaments to follow particularly the angular lines of the joint; and in severing the strong anterior ligaments, it is directed by Sedillot to carry the point of the bistoury four lines behind the union of this metacarpal bone with the third, and cut upon the bone at the same time that its anterior extremity is pressed downwards, in order to effect the luxation.

Flap method. (Pl. XXXV. fig. 4.)—The bistoury is to be carried vertically, so as to divide one of the interosseous spaces from the commissure of the fingers up to the carpal bones, prolonging the incision in the skin a little above the joint both on the dorsal and palmar faces. Drawing upon the finger about to be removed, while the adjoining one is held separate by an assistant, the surgeon passes the bistoury a second time from the back to the palm at the upper angle of the wound and on the opposite side of the bone, and brings it downwards, shaving the bone, so as to cut a second flap, emerging at the commissure on the other side of the finger. In making this second incision, the skin and soft parts are to be drawn to the opposite side, so as to diminish the amount of the structures removed. The bone is next to be disarticulated as in the oval process.

It is occasionally in our power, by removing two or more of the metacarpal bones together, to retain a portion of the hand that ultimately becomes very useful. I have removed, in a case of gunshot injury, the os magnum with the corresponding metacarpal bone and finger, and the hand has been preserved with its uses but little impaired. Benahan has taken away the first two metacarpal bones with the trapezium, trapezoides, and scaphoides; and M. Sully the last two metacarpal bones with the unciform, pisiform and cuneiform. No distinct formula, however, can be given for such irregular operations.

Dressing.—The vessels, which are numerous and important in the palm, must be carefully tied. The removal of the fourth metacarpal bone, by the flap operation especially, is attended with a division of the terminal branch of the ulnar arterial arch and the second radial interosseal artery;—the middle finger, with that of the ulnar and radial arches or their digital branches. The parts are to be closed by adhesive straps and bandages, and kept constantly irrigated with cold water or some cooling lotion, in order to keep down inflammatory action.

AMPUTATION OF THE FOUR METACARPAL BONES OF THE FINGERS TOGETHER AT THEIR METACARPO-CARPAL JOINTS. (Pl. XXXIV. FIG. 4.)

The amputation of these bones in a mass is attended with less difficulty than the disarticulation of a single bone. It is necessary,

however, for the surgeon to have a precise knowledge of the position, structure, and zigzag direction of the line of articulation, else he will become embarrassed, or be compelled, as I have had occasion more than once to observe, to use the saw in their separation. An outline of this articulation is seen at Pl. XXXIV. fig. 5. It is most essential to ascertain at the commencement of the operation the terminal points of the line, and for which the directions have already been given in the process for the disarticulation of the second and fifth metacarpal bones. The course of the line in the main is strictly convex, with an inclination downwards and inwards. The articular heads of the second and fourth metacarpal bones are nearly on the same level. The articular surface of the third is about a line in front of these; that of the fifth, on the contrary, is about half a line nearer to the wrist. The space between the metacarpal bones of the thumb and index finger is large, and these bones may be said to be at their bases merely in juxtaposition. By examining the outline drawing above referred to, it will be seen that the metacarpo-carpal joint of the thumb is directed obliquely forwards and inwards, and is found at its inner edge about the sixth of an inch lower than that of the fore finger. All the metacarpal bones of the fingers are united together by dorsal and palmar ligaments. Their joints are connected, by an extension of the synovial membranes, with those of the proper carpal bones, the inflammation of which, if it should follow amputation, might be attended with serious consequences.

Operation.—An assistant presses on the radial and ulnar arte-

ries so as to command these vessels. The surgeon with the left hand applied over the dorsal surface, which should be uppermost, grasps the fingers and makes a semilunar incision convex downwards a little more than half an inch in front of the articulation, commencing at the joint of the fore finger if it be the left hand, or at that of the little finger if it be the right, and ending at the opposite margin of the articular line. The skin is then to be retracted by an assistant, and the extensor tendons divided by another incision on a line with the joints. The operator is now to raise the knife nearly to a vertical position and run the point along the line of articulation, following exactly the zigzag direction above described, so as to cut the dorsal ligaments, but without attempting to penetrate into the joints. When they are all divided, he presses the end of the metacarpal bones downwards so as to luxate them at their base. He next passes his knife into the gaping joints so as to complete the division of the ligaments, and insinuating the blade flatwise under the heads of the bones, shaves their anterior surfaces, and cuts outwards into the palm, so as to form a flap an inch to an inch and a half in length.

This process may, at the will of the surgeon, be reversed, first cutting the palmar flap, then the dorsal, and luxating the bones in the manner described. In cases of necessity, the metacarpal bone of the thumb may be removed with those of the fingers. The operation terminated, it only remains to tie the trunks of the radial and ulnar arteries, and bring the flaps together with adhesive straps and a roller bandage.

PLATE XXXVI.—AMPUTATIONS OF THE WRIST, AND OF THE THIRD METACARPAL BONE.

(Fig. 1.) AMPUTATION IN THE CONTINUITY OF THE THIRD METACARPAL BONE.

An incision has been made on either side of the metacarpal bone, so as to form a V. The hand of the patient is sustained by that of an assistant (*a*), who at the same time grasps the little bands which have been applied to separate the soft parts from the bone and protect them from the action of the saw. The surgeon with his left hand (*b*) holds the end of the metacarpal bone, while he divides it with a narrow saw near its junction with the carpus.

(Figs. 2, 3.) CIRCULAR AMPUTATION AT THE RADIO-CARPAL JOINT.

Fig. 2.—The stage of the operation shown is that when, after the circular division of the skin, the knife has cut the extensor tendons and passed through the joint for the purpose of dividing the ligaments on the palmar side.

a. Left hand of an assistant, sustaining the stump.

b. Left hand of the surgeon holding that of the patient, while with his right (*c*) he finishes the disarticulation.

Fig. 3.—This shows the surface of the stump after the operation in fig. 2. The surgeon has seized the mouth of the radial artery with the forceps (*d*), around which the hands of an assistant (*e*, *f*) are seen applying the ligature. The hand of another assistant (*g*) sustains the stump.

Fig. 4.—Closure of the wound with three adhesive straps, after the amputation at the same joint by two flaps, the larger one being formed by incision over the dorsal surface.

(Fig. 5.) DOUBLE FLAP AMPUTATION AT THE RADIO-CARPAL JOINT. (*Process of Lisfranc.*)

The fore arm is sustained with the hand of an assistant (*a*); the left hand of the surgeon (*b*) grasps that of the patient. The palmar flap has been cut by puncture, with the hand in a state of supination, and the operation is shown at the moment the surgeon is about to finish cutting the dorsal flap with the hand in a state of semi-pronation.

Fig 2

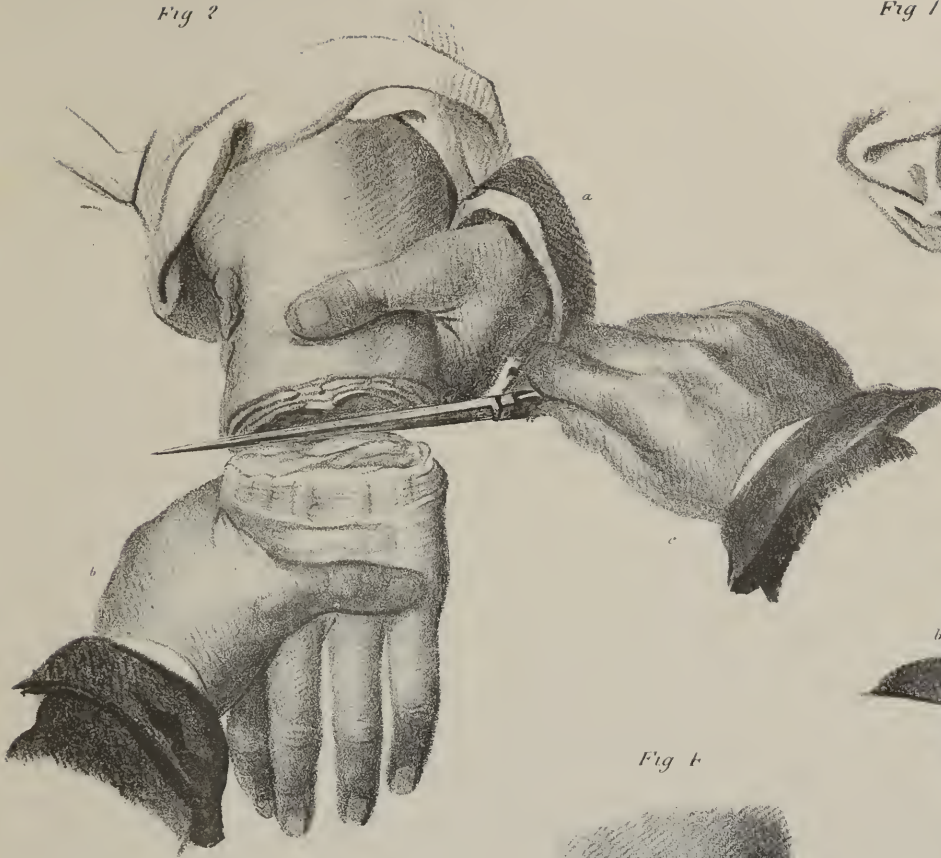


Fig 1



Fig 4

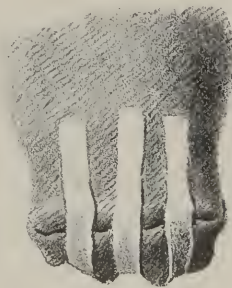


Fig 3

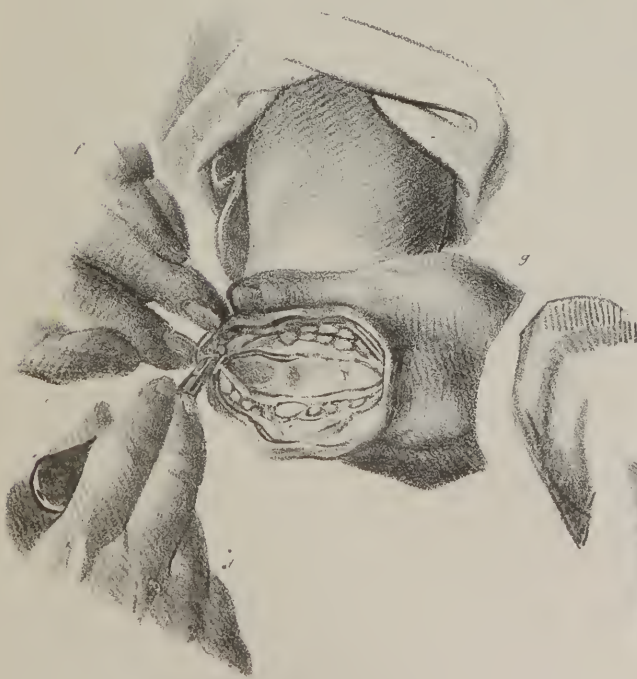
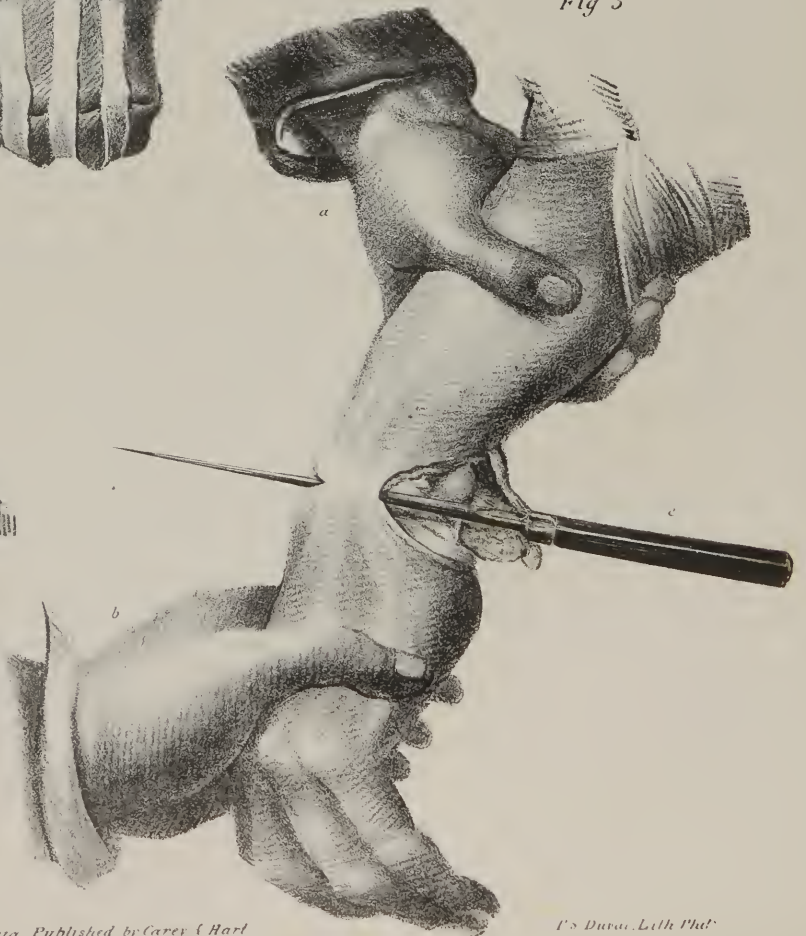


Fig 5



AMPUTATION IN THE RADIO-CARPAL ARTICULATION.

This has latterly, notwithstanding the amount of prejudice usually entertained against disarticulation, become a very common operation. It is especially applicable in all such injuries or diseases of the hand as have spared the articulation of the wrist and its integuments; and the great success which has attended its performance, shows that it should always in such cases be resorted to in preference to amputation in the continuity of the forearm.

Surgical anatomy.—Of the four bones of the upper carpal row, the three outer only enter into the structure of the joint—the scaphoides, the lunare, and the cuneiform. The upper surfaces of these bones form together an oblong polished head, which is received into a corresponding shallow socket or depression on the conjoined extremities of the radius and ulna, the styloid processes of which may be readily distinguished through the skin bounding the two sides of the joint.

The exact seat of the joint may be readily determined by the following indications. Draw a straight line from the point of one styloid process to the other, and the joint will be found in the direction of a curve, the highest point of which passes about a quarter of an inch above the middle of the straight line. This curvature in the direction of the articulation should be well understood; for if the disarticulation should be made directly across, the separation will be found to have taken place between the two ranges of carpal bones. The palmar face of the wrist in a state of flexion presents three lines, which may serve as a guide to the articulation. The one next the palm (the hand being held straight) corresponds to the joint between the two ranges of carpal bones. The middle one, half an inch above the former, indicates the position of the radio-carpal joint; and the third, which is an inch above the middle one, and sometimes very faintly marked, is on a line with the junction of the epiphyses with the shafts of the bones. When the hand is bent firmly back, the summit of the angle, as observed by Malgaigne, which it forms with the forearm, corresponds exactly with the position of the joint.

It is well, also, to notice that the scaphoid bone projects a little higher up than the lunare or cuneiform, and that the pisiform of the lower row protrudes a little in front of the carpus, and that the knife of the surgeon during the operation must turn around these bones.

The capsular ligament of the joint is in itself thin and membranous, but it is strengthened by lateral ligaments on its sides, and by the fibrous sheaths of the tendons on its dorsal and palmar faces.

The circular method or the flap may either be employed in amputation at this joint, but in consequence of the absence of muscular tissue, and the liability of the styloid processes to become uncovered at the angles of the flaps, the former will be found to yield the most satisfactory results.

Circular method. (Pl. XXXVI. figs. 2 and 3.)—An assistant retracts circularly the skin, and at the same time commands by pressure the circulation in the radial and ulnar arteries. The surgeon, grasping with his left hand the one about to be operated on, places it in semi-pronation, with the back turned towards him. With a small straight-edged knife, he then makes a circular incision through the integuments, which shaves the thenar and

hypothenar eminences of the hand, following the lower of the three lines on the palmar surface of the wrist. The skin, which is alone to be divided, is then to be dissected up and reverted as high as the articulation, taking care not to loosen with it the pisiform bone. By another circular cut carried round from the lower edge of one styloid process to the other, the tendons and lateral ligaments are divided completely across. All that sustains the articulation now, is the thin capsular ligament. This may be opened with a scalpel, either on the front, back or side, at the will of the operator, and the wrist luxated and detached by following with the blade of the instrument the curved line of the joint.

By the formation of two flaps. (Pl. XXXVI. figs. 4 and 5.)—The hand placed and sustained as above described, the surgeon makes on the back a semilunar incision through the integuments, commencing half an inch below one styloid process, and terminating the same distance below the other,—the middle part of the curve being about two inches lower. The flap of skin thus formed, and loosened by one or two cuts of the knife, is to be raised and drawn back by an assistant. The surgeon then divides on a level with the joint the extensor and radial tendons, the posterior part of the capsular ligament, the lateral ligaments and the tendon of the carpal extensor. He next presses downwards the palm so as to luxate the carpus, and carrying his knife through the joint, detaches the extremity by cutting a flap on the anterior surface an inch or more in length. It has been directed to raise the handle of the knife in this last step, so as to avoid including the pisiform bone in the flap. But it is probable that little inconvenience could result from its being left with the skin, and we would thereby preserve the attachment of the flexor carpi radialis.

This process may be often conveniently modified according to the peculiar seat and the extent of the lesion for which the operation is performed; and it is perfectly easy to cut either a dorsal or palmar flap of sufficient dimensions to cover the ends of the bones, if the integuments have been destroyed on one of the faces of the wrist.

The process of Lisfranc, (fig. 5,) which is inferior in value to either of the others, consists in passing a catling or double-edged knife across the anterior face of the wrist, from a point just below one styloid process to the lower edge of the other, and shaving downwards the surface of the wrist bones, so as to form an anterior flap. A semicircular incision is then made by puncture on the dorsum, and the flap thus formed dissected up. The knife is next passed under the styloid process of the radius, and swept along the curved line of the joint, so as to complete the disarticulation.

Dressing. (Fig. 4.)—The radial and ulnar arteries are to be tied. It has happened, however, that these vessels have retracted so much that their orifices could not be found; and experience has shown that under such circumstances no secondary hemorrhage is liable to follow. The integuments are to be closed by adhesive straps passed from the back of the arm; and a roller bandage is to be carried from the elbow downwards, in order to overcome the excessive tendency to retraction of the skin and muscle. At the lower extremity of the forearm it is also well to apply some longitudinal compresses, in order to flatten the synovial sheaths and prevent suppuration of their cavities.

2. OF THE FORE ARM.

AMPUTATION IN THE CONTINUITY OF THE FORE ARM.

Surgical anatomy.—The fore arm, like the leg, is covered with muscles that degenerate in their inferior portion into tendons, which are enveloped by synovial sheaths more or less continuous with those of the palm. The presence of these tendons and their synovial sheaths, the liability to the propagation of inflammation upwards along the latter, and the fear that in the absence of the muscular structure the skin would cicatrize tightly over the ends of the bones, so as to make painful pressure on the extremities of the nerves, deterred the older surgeons from amputating in the lower half of the arm. But the experience of latter times has shown that the general rule of removing as small a portion as possible, is as applicable to the amputation of the fore arm as to any other part of the body, that the extension of synovial inflammation may be prevented by judicious treatment, and the tight adhesion of the cicatrix to the bone avoided, by giving a sufficient degree of extent to the cutaneous covering. In the amputations of the fore arm, the circular, oval, and flap methods are all occasionally employed.

In a surgical point of view, the fore arm may be divided into three sections. The inferior, which is flattened somewhat like the palm, is well suited to the flap operation, *provided care is observed* to turn back the flaps so as to reverse a portion of the uncut skin above the angles of the wounds, in order to divide the bones higher up and prevent their edges subsequently protruding at these

points. Either of the other methods may be employed at the will of the surgeon—but in my hands they have not served to form so neat a stump. In the middle region the arm is conical, and the flap is particularly appropriate here, in consequence of the difficulty of dissecting up and turning back towards the base of the cone the sleeve-like fold of skin. The upper third of the arm is round and muscular, and well suited for either form of amputation, though the circular has been more generally employed. In the fore arm, where there are two bones to which the muscles are extensively connected, it has been observed that the muscles retract but little after their division; and the surgeon must bear this in mind during the operation, so as to cut his covering of skin of sufficient length, and if necessary, as it usually is, dissect off the muscles from the bones for a little space before applying the saw.

Circular method. (Pl. XXXVII. figs. 1, 2, 3.)—The patient is to be placed upon the edge of his bed, or seated on a chair. The brachial artery is to be compressed with a tourniquet, or the fingers of an assistant, and the fore arm partly flexed and put in the middle state between pronation and supination, and well supported by assistants. The surgeon, placing himself at the inner side—a position that gives him a greater facility in dividing the bones—grasps with his left hand the fore arm above or below the point of operation, according to the limb upon which he acts. A straight-edged amputating knife is then carried, with the right hand well pronated, under the arm to the upper surface of the radius, and the integuments divided down to the fascia in a circular sweep, the knife coming round to the point from which it

PLATE XXXVII.—AMPUTATIONS OF THE FOREARM.

(Figs. 1, 2, 3.) CIRCULAR AMPUTATION OF THE FOREARM OF THE LEFT SIDE.

Fig. 1 represents the first stage of the operation. A circular incision has been made, and the integument is seen raised with the left hand of the surgeon (*a*), while it is detached from the aponeurosis with the knife in the right (*b*).

Fig. 2 shows the face of the stump at the conclusion of this circular operation. The stump is supported by the left hand of an assistant (*c*). The three ligature threads (*d*) which have been applied to the radial, ulnar, and anterior interosseal arteries, are seen hanging from the side of the wound.

Fig. 3 represents the appearance of the stump after the closing of the wound with four adhesive straps.

(Fig. 4.) DOUBLE FLAP AMPUTATION OF THE FOREARM AS PRACTISED BY THE AUTHOR.

The surface of the stump is shown after the completion of the operation.

f. Right hand of an assistant supporting the stump.

g. Anterior flap reverted; which, in consequence of the greater thickness of the soft parts on this side, has nearly twice the length of the posterior flap (*h*).

(Fig. 5.) CIRCULAR AMPUTATION AT THE ELBOW JOINT. (*Process of Velpeau.*)

A circular section has been first made of the skin, and secondly one of the muscles, so as to give to the stump the appearance of a hollow cone, as in the modification of M. Cornuau. The operation is shown at the moment when the knife (*m*), which has been passed through the joint, is applied so as to divide the tendon of the triceps above the head of the olecranon process. The right hand (*i*) of an assistant compresses the humeral artery; the left hand of the surgeon (*k*) sustains the forearm. The sloping direction of the section of the muscles of the fore arm, which leaves the heads of the radius and ulna prominent, is seen at *l*.

Fig. 3.



Fig. 1.

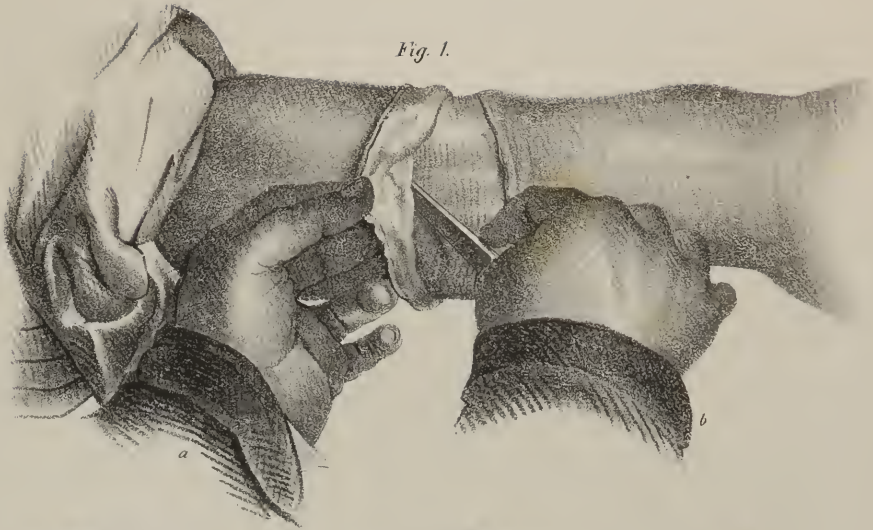


Fig. 4.

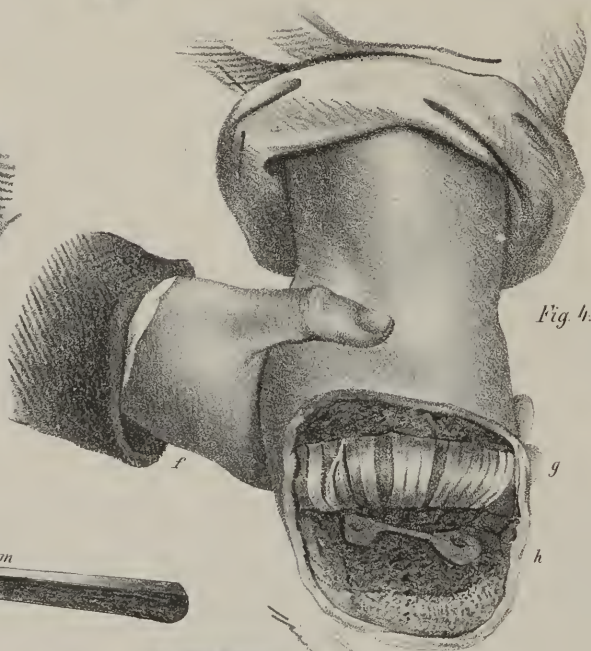


Fig. 5.

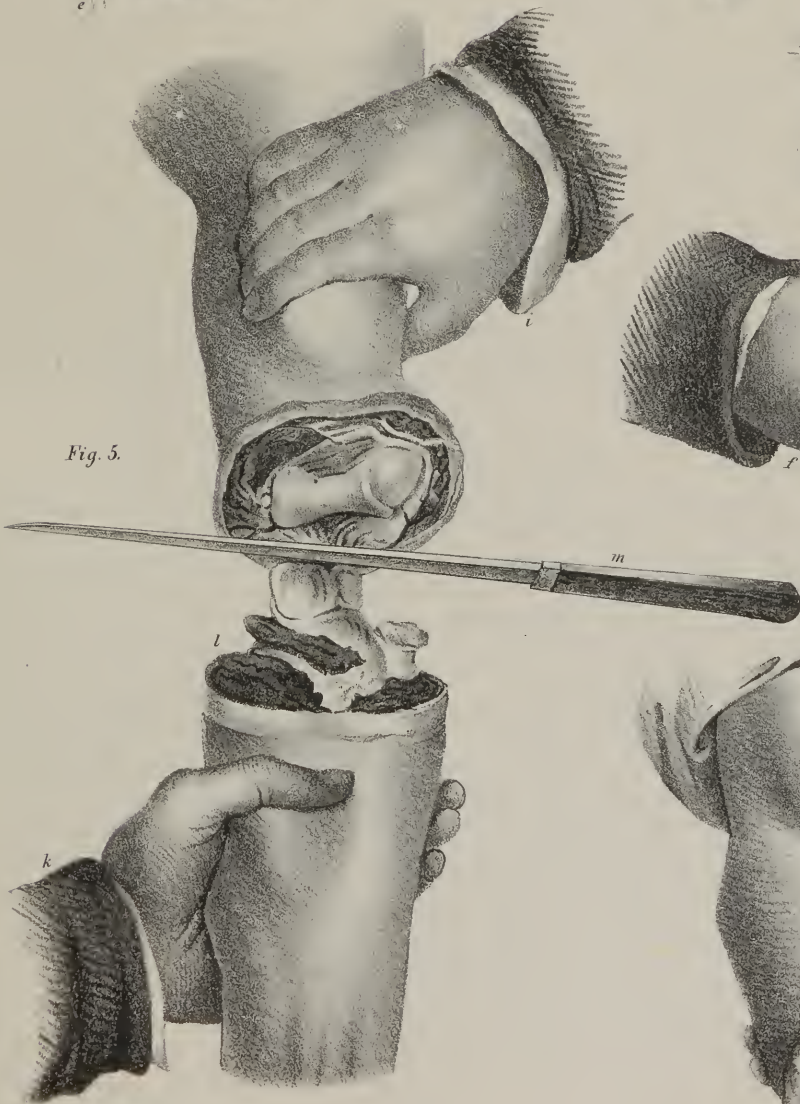
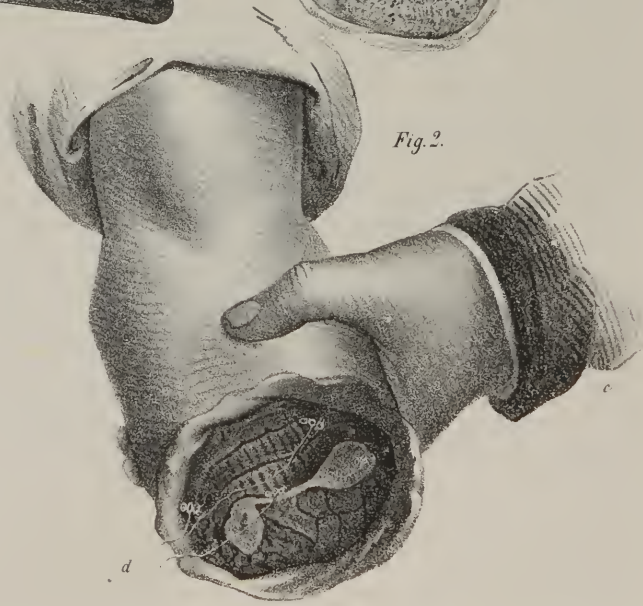


Fig. 2.



started, by allowing the hand which holds it to turn during the circuit into a state of supination. The integuments are to be dissected from the fascia for an inch or more, according to the thickness of the limb, and reversed. If on account of the conical shape of the limb difficulty should occur in turning back the skin, it may be slit over the radial and ulnar bones. By another circular incision the muscles are divided down to the bone nearly on a line with the base of the reflected skin. When the tendons are strong, there is a difficulty in dividing them in the circular sweep, and it is well to follow then the practice of Cloquet, by running a catling through on each face of the interosseous ligament, and cutting outwards. The cut muscles now retract; a narrow interosseous knife or catling is passed into the gap to divide the interosseous ligament and the interosseous muscles, both on the front and back of the bones. The retractor is next adjusted with the middle tail passed between the bones, and the muscles and skin drawn back out of the way of the saw. The saw is now to be applied on the face of both the bones, the radius being held in the middle state between pronation and supination, in order that it may not be left too long; and the section of the ulna completed last, in consequence of this bone being most firmly connected with the humerus. The retractor is then removed; the radial and the ulnar arteries, and occasionally the interosseal, tied. The wound is to be closed with adhesive straps, and supported with a roller bandage, making the line of reunion correspond with that of the end of the bones.

Malgaigne has lately proposed, as a modification of the circular operation, to form a flap of the muscles, about an inch long, on each side of the arm after the reflection of the skin, by passing the catling flatwise on each face of the interosseous ligament.

Flap method.

Single flap.—Græfe, following the process of Verduin and Ruysch, passed the catling through from side to side in front of the bones and interosseous ligament, and cut out so as to form a semi-elliptical flap on the front part of the fore arm. The skin and soft parts on the back were then divided down to the bone by a semicircular incision. The remaining muscular fibres and the interosseous ligament were then divided, the soft parts retracted, and the bone sawed in the usual manner.

Double flap. (Pl. XXXVII. fig. 4.)—This method is more frequently employed than the preceding, and is of very easy execution. The fore arm placed in the middle state between pronation and supination, so as to render the two flaps of more equal size, the surgeon glides the knife across the arm either from the ulnar or radial edge, shaving the faces of the bones and the interosseous ligament, and cuts downwards and outwards so as to form an anterior flap two inches or more in length according to the size of the arm. The lips of the wound are then to be drawn backwards, and the knife carried over to the opposite side of the bones, and passed from the upper angle of the incision to the lower without making a new puncture in the skin, so as to form a posterior flap nearly of the same size as the anterior. An assistant then raises the flaps, the surgeon cuts the interosseous ligament and remaining muscular fibres, and divides the bones with a saw.

To prevent any possibility of the subsequent exposure of the bones at the angle of the wounds, I am in the habit of further loosening the flaps at the base with the knife, but without dividing

the skin—an assistant at the same time drawing them strongly upwards—then applying the three-tailed retractor, and finally dividing the bones so that after their section they shall be half an inch above the upper angles of the flaps.

Sir Charles Bell preferred to cut the flaps with a common amputating knife from without inwards, in order to avoid the irregular division of the tendons and muscles, which will sometimes take place to such an extent by the opposite mode of cutting the flaps as to require subsequent trimming. He made his anterior flap much larger than the dorsal, and observed the precaution to divide the bones high up. I have employed this process, and found it to form a handsome and most serviceable stump. The only objection to it, which is not one of much moment, is, that the muscles recede to some extent into the interosseous hollow before the edge of the knife, leaving a considerable amount of fibres to be cut with the catling in the second step of the operation.

Mixed process.—M. Sedillot cuts a thin, short flap, on either side of the fore arm, elevates them, and divides the muscles circularly, or with a slope upwards at their base, down to the bone, which he cuts in the usual manner with the saw. M. Baudens prefers, in the inferior two-thirds of the arm, to divide the skin circularly, to dissect and turn it upwards to the amount of three fingers' breadth, and then passing his knife through at the base of the fold on either surface of the bones, cut from within outwards two short, thick muscular flaps an inch in length. These are to be drawn upwards by an assistant, while the operator isolates the bones and divides them in the usual manner with the saw.

AMPUTATION AT THE ELBOW JOINT.

The amputation at this joint, first executed by Ambrose Paré, has been revived and practised to a considerable extent in latter times. It has not, however, by any means, received the general sanction of the profession, though it has been warmly supported by Dupuytren and others, and is considered by Velpeau as less dangerous than the amputation of the arm, the only alternative when we reject the operation at the joint. It is, however, a great advantage to the patient to be able to preserve the entire length of the arm, and it is at least certain that the disarticulation has been attended with a fair average of success. In cases of injury of the fore arm, when there is no chronic affection of the joint, and the structures about the humerus are uninjured, the surgeon might feel himself justified, in the hope of preserving a more useful member, to encounter the difficulties of disarticulation at this joint and the dangers attendant upon the extensive and slowly healing wound which it necessarily leaves.

Surgical anatomy.—The exact position of the joint may be ascertained by the careful observance of the following rules. The lateral prominences or tuberosities at the lower extremity of the os humeri, too often considered by those deficient in anatomical knowledge as being on a level with the joint, are placed at unequal distances above it. The internal one, which is most prominent, is nearly an inch above the junction of the ulna with the pulley of the humerus; the external, about half an inch above the articulation of the radius with the condyle of the humerus. The tuberosi-

ties are placed nearly on the same horizontal level; and in consequence, the articular line is directed from within obliquely outwards and upwards. The base of the anterior flap, therefore, should be cut obliquely, and never so high as the tuberosities, lest it should be found too short to cover the end of the bone. When the integuments are not diseased, the head of the radius may be felt rolling in its joint, so as to serve as a guide to the general articulation. The articular surfaces of the radius and ulna being *nearly* on the same level, and forming a line in front interrupted only by the slight elevation of the coronoid process, we are enabled at once to carry a knife by a single cut directly into the anterior portion of the joint. Between the radius and the humerus, the knife may be readily passed from the outer side into the joint; but on the internal side, its entrance is resisted by the olecranon and coronoid processes. On its posterior face, the line of the articulation is of a shape like that of the letter J reversed, the body of which is formed by the olecranon; the internal transverse branch, which is the shortest and highest of the two, by the internal side of the coronoid process; and the external branch, by the condyle of the humerus which articulates with the radius.

A strong lateral ligament is found on either side of the joint; in front and behind, the capsule is thin and membranous. After the ablation of the fore arm, the end of the humerus presents a large surface, which will require a considerable extent of skin or flap to cover it thoroughly, and prevent the exposure of the bone.

The oval, circular and flap methods have all been employed for this disarticulation; and rank in regard to appropriateness in the order in which they are enumerated. In the circular, there

will be but one artery to tie,—the brachial; in the flap operation, several ligatures will be required.

Circular method. (*Process of Velpeau.* Pl. XXXVII. fig. 5.)—The surgeon, standing at the outer side of the limb, divides the skin circularly in the ordinary manner, at the distance of three fingers' breadth below the line of the articulation, or that of four fingers below the tuberosities of the humerus. He then dissects and turns back the skin to the level of the joint, and by a second circular incision, divides at this height the soft parts down to the bone. The fore arm is then to be strongly extended, and the anterior and lateral ligaments divided with the knife, rocking the joint from side to side as the latter are cut. Drawing downward upon the fore arm so as to separate the head of the two bones from the articular surface of the humerus, the knife is carried backward so as to cut the tendon of the triceps at its insertion upon the olecranon, divide the posterior ligamentous fibres, and thus complete the disarticulation. If found more convenient, the olecranon process may be divided at its base with the saw, and left adherent to its tendon. Its removal, however, gives more regularity to the surface of the stump, and diminishes the extent of the wound; it has moreover been ascertained that the triceps will contract new adhesions, so as to move the arm perfectly after it has been detached from this process.

The covering of the stump will consist merely of the skin and subcutaneous cellular tissue, the edges of which are to be drawn together so as to form a linear wound from side to side.

In order to leave some fleshy covering for the ends of the bones, M. Cornuau, who follows in other respects much the same process,

PLATE XXXVIII.—AMPUTATIONS OF THE ARM.

(Fig. 1.) FLAP AMPUTATION OF THE RIGHT ARM AT THE ELBOW JOINT. (*Process of Dupuytren.*)

The anterior flap has been cut by puncture and reverted upon the arm, the soft parts divided on the back part of the joint, and the ligaments of the joint severed so as to effect the disarticulation of the arm. The saw is seen applied for the purpose of dividing the olecranon, which in this process is left attached to the tendon of the triceps.

- a. The hand of an assistant compressing the artery.
- b. The left hand of the surgeon sustaining the fore arm.
- c. The saw with which the olecranon is cut.

(Figs. 2, 3, 4.) CIRCULAR AMPUTATION AT THE MIDDLE OF THE ARM OF THE LEFT SIDE.

Fig. 2. *Section of the soft parts.*

A circular section has been made of the skin, and of the two layers of muscles, as described in the text. An assistant compresses the brachial artery with his right hand (*d*), while with his left (*e*), he sustains the upper part of the arm, and at the same time retracts the divided tissues.

- f. Left hand of the surgeon supporting the lower end of the arm. The conical projection of the divided muscles on the inferior fragment is shown at (*g*). The conoidal hollow of the end of the upper fragment (*h*), is partly effaced by the retraction of the soft parts made by the assistant. The knife (*i*) is shown as it is brought round by the right hand of the surgeon, so as to complete the section of the layer of deep-seated muscles over the bone.

Fig. 3.—*Surface of the stump raised by the hand of an assistant (k).*

It presents the appearance of a hollow cone, and shows the ligatures applied upon the divided arteries.

Fig. 4.—*Coaptation of the lips of the wound over the end of the bone, by means of four strips of adhesive plaster.*

The ends of the ligatures project from its inferior angle.

Fig. 2

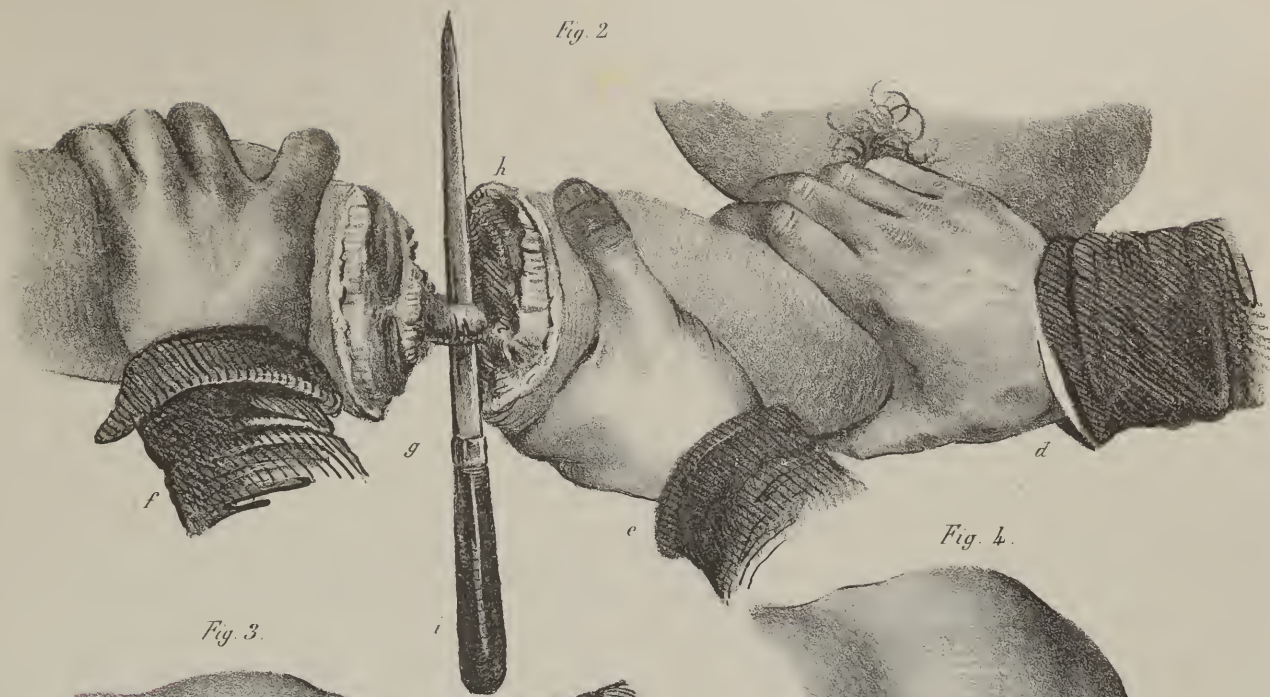


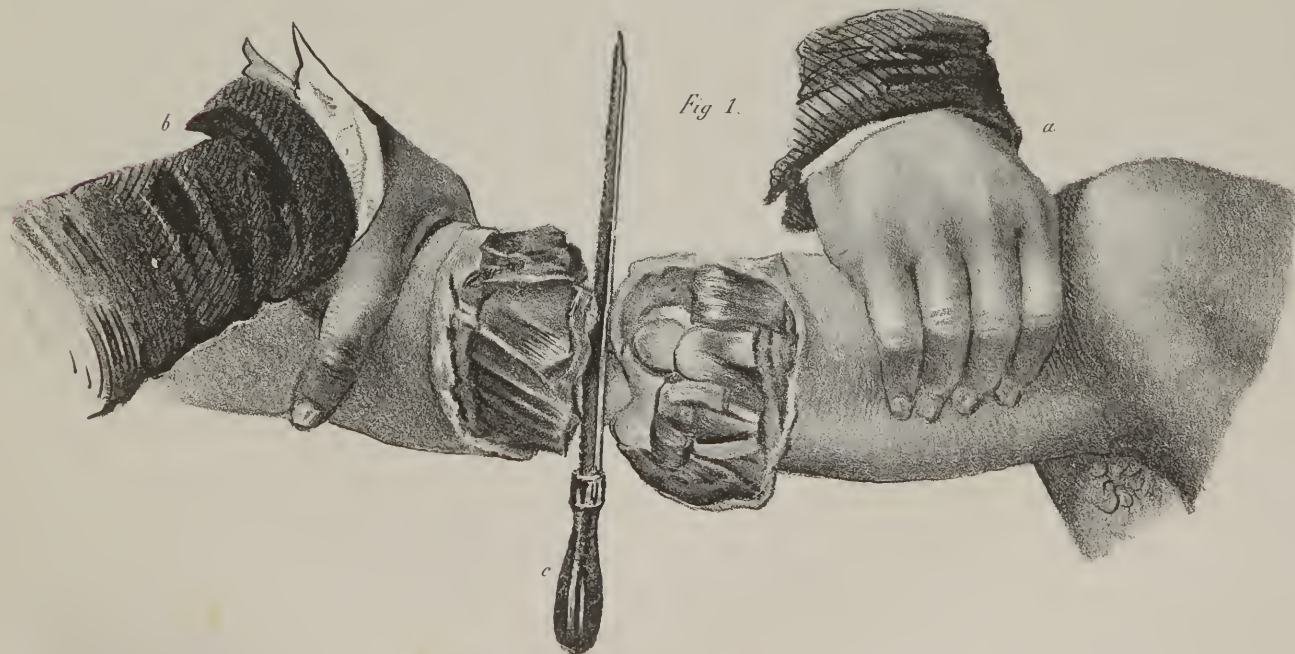
Fig. 3.

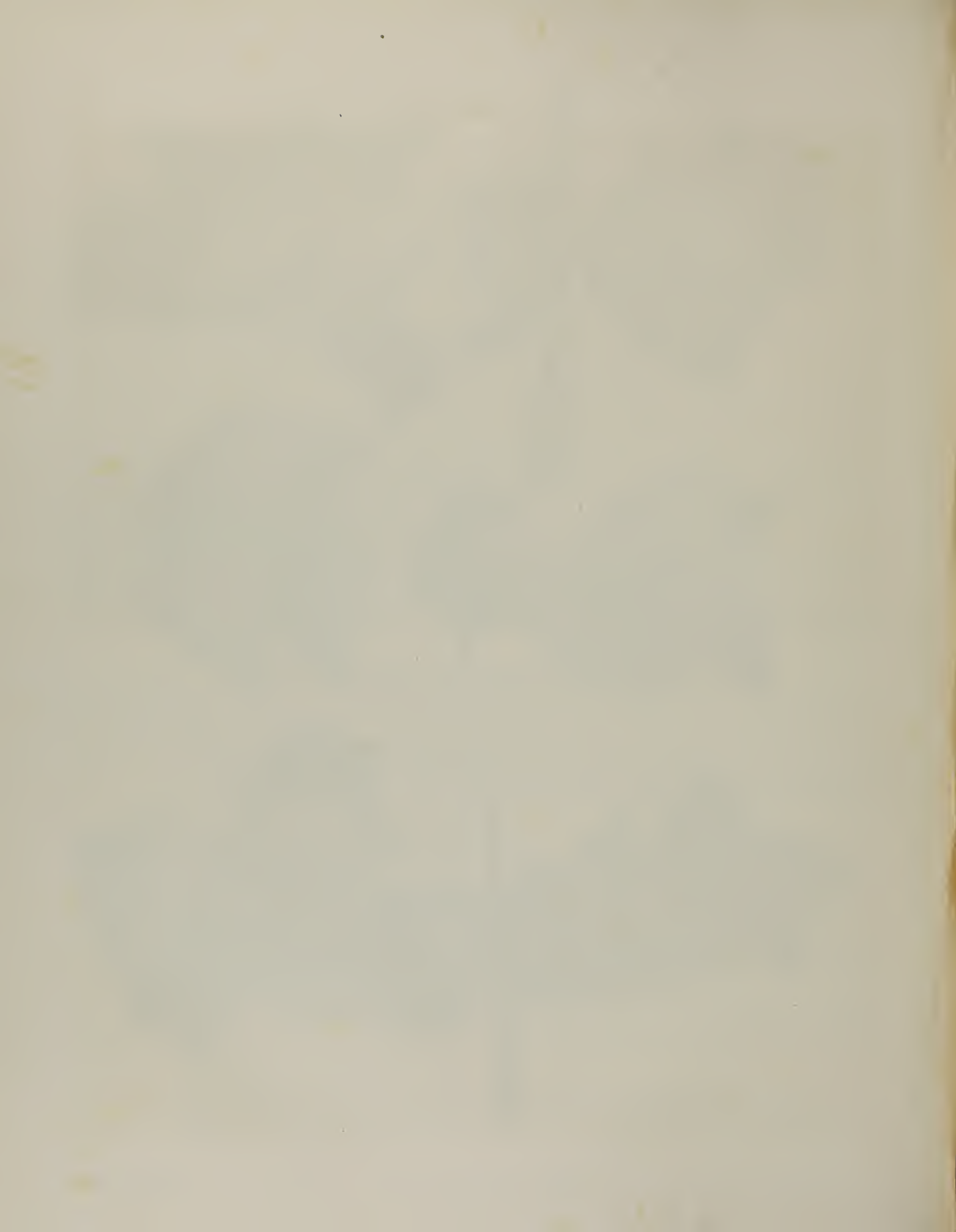


Fig. 4.



Fig 1.





cuts the muscles a little distance below the joint. The brachial artery will then be divided after its bifurcation into the radial and ulnar, and two ligatures will be required.

Oval method. (*Process of Baudens.*)—The patient is seated on a chair, with the fore arm extended and turned so as to present its external face upwards; an oval-shaped line is marked round the arm with ink, commencing at the external border of the radius, four fingers' breadth below the outer tuberosity of the humerus, and carried so as to cross the ulna two fingers' breadth nearer the joint, in order to leave less skin on the ulnar side, and admit the escape of the watery discharges which occur during the progress of the cure. The integuments are to be divided along the traced line down to the fascia, and the internal semilunar flap dissected up and reverted as high as the internal margin of the oval. On a level with this point the superficial layer of muscles are to be cut with a circular sweep of the knife; then, drawing upwards the divided portions with the left hand, the knife is applied a second time so as to cut the remainder of the muscles on a line with the joint, and is entered at the termination of the sweep, between the head of the radius and the os humeri. The ligaments are next divided, as in the circular operation, and the fore arm detached by sawing the olecranon at its base. At the bottom of the wound will be seen the end of the humerus, surrounded by the divided muscles, and bordered by a large external flap, which will abundantly suffice for the covering of the stump. A patient upon whom this process of disarticulation was performed, was perfectly cured at the end of a month.

Flap method. (*Process of Dupuytren slightly modified.* Pl. XXXVIII. fig. 1.)—The fore arm supinated, and one-third flexed, the operator, standing on the inner side, ascertains with the thumb and middle finger of the left hand the position of the two tuberosities of the humerus, and grasping the soft parts immediately below, raises them so as to facilitate the passage of a double-edged knife or catling across the face of the bones, from the inner to the outer side, *immediately over the line of the articulation.* In order to get as large an anterior flap as possible, the handle of the knife should at first be depressed so as to enter the point through the integuments posterior to the front face of the ulna, then raised horizontally as the point crosses the joint, and again elevated as it emerges in order to pierce the skin as far back as possible on the outer face of the radius. The knife is to be carried downwards, shaving the face of the bones, so as to cut, according to the thickness of the limb, a flap three or four inches long, which is to be drawn upwards by an assistant. The knife is now shifted to the posterior part of the limb, in order to make a horizontal division of the soft parts there, on a level with the base of the flap. The fore arm is next to be extended, the anterior and lateral ligaments divided as above described, and the division of the limb effected either by cutting the tendon of the triceps or sawing the olecranon at its base.

Brasdor began the operation by making a semicircular division of the skin, convex downwards, a few lines below the top of the olecranon. He then cut the tendon of the triceps, the lateral ligaments, and running the knife through on the face of the bones of the fore arm, cut a large anterior flap.

Sedillot, holding the arm semiflexed, opens the integuments nearly in the same manner on the back, by making a semicircular

incision which covers about one-third of the circumference of the limb, crossing it at its middle, an inch below the top of the olecranon. An assistant draws up the skin so as to allow the operator to divide the tendon of the triceps and the posterior and lateral ligaments, and lay open the radio-humeral articulation by following the line of the joint. From the external extremity of the first incision, he then (before attempting to luxate the bones) drops a vertical cut two inches long. He now carries the fore arm, still flexed, backwards and inwards, and disarticulates it by dividing the remaining portions of the ligaments. A knife is then carried through the joint to the front of the bones, and the operation is terminated by cutting an anterior flap, which comprises the remaining two-thirds of the whole circumference of the limb. In operating on the *left* elbow, the vertical incision is to be made and the disarticulation commenced on the internal side. The value of this process has not yet, however, been tested by its application to the living subject.

Dressing.—In the flap operation there are always two arteries at least to tie, and occasionally the trunk of the brachial is injured by the puncture with the catling, so as to require a ligature. The flaps are to be drawn together, or the circular fold of skin closed with adhesive straps, in the manner which will most completely cover the end of the humerus.

3. OF THE ARM.

AMPUTATION IN THE CONTINUITY OF THE ARM.

Surgical anatomy.—The arm has but a single bone, which is everywhere completely enveloped with muscles, except in the neighbourhood of the elbow joint. These muscles may be arranged into two classes—those which have for their chief office to move the fore arm, and those which move the arm. The first class consists of the two flexors on the front and inner part of the arm, the biceps flexor, and the brachialis anticus, and one extensor—the triceps extensor cubiti. The brachialis and the triceps are attached to the bone throughout their entire length, and are therefore susceptible of little secondary shortening after division in an amputation. But the biceps lays loose in its whole extent, and, like several muscles of the thigh, shortens itself to a great degree when cut. In amputation in the lower two-thirds of the arm, it is therefore advised to put the fore arm in a moderate state of flexion, and to cut the biceps a little lower than the other muscles. In the upper third the bone is surrounded with the second class of muscles, that consist, besides the articular—which are concerned only in the operation for disarticulation at the shoulder joint—of the powerful deltoid, the coraco-brachialis, and the muscles of the armpit—the great pectoral, the latissimus, and the teres major. In amputation in the upper third, the action of these muscles forms a subject for consideration. If the operation is performed so as to leave in part the insertion of the muscles of the armpit, the deltoid, coraco-brachialis, and biceps are cut off from their insertion, and are liable to retract so as to leave a conical stump, and by drawing up the integuments retard the healing of the wound. If the section be made above the insertion of the armpit muscles, the latter will retract upon the chest so as to leave the bone nearly naked, and the stump will occasionally be made

to stand straight outwards by the unresisted action of the supra and infra-spinatus muscles. For these reasons Lafaye and Larrey preferred amputation at the shoulder joint to that through the upper third of the arm. But this practice has been generally and justly rejected by most surgeons. It has been found that it is more dangerous than amputation through the arm; that every inch of the humerus that can be preserved consistent with the formation of a good stump becomes of great value to the patient; and moreover, that the two other articular muscles, the subscapularis and the teres minor, prevent most commonly the permanent elevation of the stump. The operation through the bone, with a single large external flap, is, therefore, when the case admits it, to be preferred to that through the joint.

In cases where the amputation is made at the lower border or through a part of the insertions of the muscles of the armpit, we obviate much of the inconvenience above mentioned in reference to this operation, by raising the arm to the horizontal position, so as to shorten the deltoid before it is cut, and then dividing the bone at a height proportioned to the degree of retraction of the deltoid, the biceps, and coraco-brachialis, which will be found to vary in different cases according to the activity of the muscles.

The circular and flap methods are both perfectly applicable to amputations of the arm in any part of its course, except near the elbow joint, where integument may be gained to cover the bone by the circular process, though there would not be room for the flap without removal of a larger portion of the bone. The oval method has also been advantageously employed by Guthrie for amputation on a line with the armpit.

AMPUTATION IN THE LOWER TWO-THIRDS OF THE ARM.

A knife of middling length, a scalpel, saw, and a two-tailed retractor, with the ordinary apparatus for dressing, are all that are required in this operation. The patient is placed in a sitting posture, and, if possible, in a chair, to which he may if necessary be secured with a towel. The arm is to be extended at a right angle with the body, and the fore arm a little flexed if the nature of the lesion will allow it. The circulation in the brachial is to be commanded with a tourniquet, or by pressure with the fingers of a competent assistant in the armpit, who is at the same time to be charged with drawing upwards the soft parts after their division. Another assistant supports the portion of the limb to be removed. The surgeon places himself at the right side of the limb, so as to be able to grasp with his left hand the parts above the place of operation.

Circular method. (Pl. XXXVIII. figs. 2, 3, 4.)—1. An assistant drawing the skin upwards, the surgeon grasps the limb with his left hand, and carrying the knife below, begins the circular incision on the edge of the biceps, dividing the skin and adipose membrane all round at a single cut down to the fascia. The integuments are then to be dissected from the fascia and turned backwards like a sleeve, for an inch or an inch and a half, according to the thickness of the arm. 2. The biceps may then be divided across separately, so as to allow it to contract; then placing the knife at the level of its shortening, divide circularly all the remaining muscles down to the bone. The assistant draws the cut edge of the muscles upwards, which then presents the

appearance of an elongated cone. The point of the cone, consisting of the deep-seated fibres, is now to be cut anew by a second circular incision down to the bone, and the deep-seated fibres subsequently separated from the bone for the space of half an inch or an inch if the arm be large, with the point of the knife. 3. The surgeon next runs his knife round the bone to divide the periosteum as well as the musculo-spiral nerve in its gutter, if this has not been previously cut, applies the retractor to draw the soft parts upward, and severs the bone with a saw at their base.

Many surgeons do not deem it necessary to make the previous section of the biceps, but complete the circular division of all the muscles at the same time. In my own practice, I have found a better stump formed by first cutting the biceps with a single stroke of the knife about three-quarters of an inch below the point at which the general circular incision is to be made. On the dead subject, where the biceps cannot shorten itself, and must be pushed up to represent the actual operation on the living, the process will not appear so neat as without the use of this precautionary measure.

Dressing.—The brachial artery, which is found on the inner side of the bone between the biceps and triceps, is to be tied. If any of its branches bleed, they are also to be secured with ligatures. The muscles are to be pressed downward with the hand, in order to cover the end of the bone, and the wound closed with adhesive straps, so as to form a line from front to back. Some surgeons, however, prefer to unite the integuments in an oblique; others in a transverse direction. The roller is to be applied from above downwards in order to prevent the spasm of the muscles, and their subsequent retraction from the end of the bone.

Flap method.—In amputation in the lower two-thirds of the arm, the operation with double flaps is very commonly preferred in Germany and England to the circular, and is employed by many of the surgeons of this country. It is more rapid, and attended with less pain during its performance, but has no other advantage over the method last described. As the bone of the arm is circularly surrounded with muscles, we may in particular instances of disease, cut the flaps with their base in any direction that will enable us to preserve the greatest length of the limb. The flaps are commonly cut by puncture and division from within outwards, but they may be also well formed in the opposite direction from without inwards.

Common process.—The patient is to be placed in the sitting posture and the limb extended and well sustained by assistants. The surgeon grasps with his left hand the muscular mass formed by the biceps and brachialis anticus, and passes the double-edged catling across the anterior face of the bone,—entering it at the internal side for the right arm, and the external for the left,—and cuts from above downwards an anterior flap two inches and a half long, which should appear regularly beveled from the centre to the circumference. The flap is now to be raised by an assistant. The lips of the wound are then to be drawn backwards with the left hand, and the knife passed behind the bone through the two angles of the wound in the skin, so as to cut a posterior flap of the same form and length as the first. Both flaps are now to be well drawn upwards, while the surgeon divides with a circular turn of the knife, the remaining fibres about the bone. When

the bone is sufficiently isolated, the surgeon applies the saw close to the base of the flap. A doubled-tailed retractor may, if preferred, be employed to draw back the flaps.

Process of Langenbeck and Bell. Section from without inwards.—The integuments drawn strongly upwards by an assistant, the surgeon standing at the inner side of the arm, sustains with one hand the arm below the place of operation, and with the other applies the amputating knife upon the skin, so as to cut from below upwards and towards the bone two flaps in succession, one on the internal and the other on the external side of the arm, each of which should be from two and a half to three and a half inches long. The assistant then raises the flaps, and the surgeon isolates and divides the bone at their base. By this process, the surgeon is required to be ambidextrous. But if he has not practised the use of the knife with his left hand, he may place himself at the outer side in operating on the left arm. One objection to this process by vertical flaps is, that it may allow the end of the bone to sink to the lower angle of the wound, so as to be exposed during the progress of cure.

Mixed process of Sedillot.—This is analogous to the one of the same author described in reference to the forearm. Two small superficial flaps are cut by puncture with a double-edged knife; the one on the external side of the limb is short, and consists but of little more than the skin and adipose tissue. The integuments are now drawn inwards, and the point of the knife carried through from the upper to the lower angle of the wound, so as to form a second flap like the first, but in which the brachial artery is not included. The flaps are next to be elevated, and the deep-seated muscles divided as in the process of Alanson,—obliquely upwards,—so as to form on the face of the stump a hollow cone, at the apex of which the bone is to be cut. This process leaves a wound very regular on its surface, and of but limited extent. It is more difficult of performance, and seems to be attended with no greater advantages than the circular method, which is remarkably well adapted to the amputation of the arm.

AMPUTATION AT THE UPPER THIRD OF THE ARM.

From the excessive tendency to shortening of the divided deltoid, and other reasons which have already been detailed, the common circular process is not so well suited as either the flap or the oval to amputations between the insertion of the deltoid on the arm and the head of the bone. The common causes that render this operation necessary, are gunshot or other injuries which have directly involved the bone, the effect of which may be found, during the course of its performance, to have extended higher than was at first supposed, so as to make it necessary to remove the bone immediately below its head, or to detach it at the shoulder joint. Under such circumstances either of the latter processes, but especially the flap, offers facilities for going above the intended place of section of the bone, without rendering necessary a second general division of the soft parts.

Process of Louis and Sabatier. (Pl. XXXIX. fig. 4.)—The arm is to be applied against the side of the body, so as to extend the deltoid and permit its being cut at its greatest length and enable the surgeon to judge of the degree to which it will shorten itself, before he divides the soft parts on the inner side of the limb.

The artery is to be compressed against the second rib above the clavicle, as in disarticulation at the shoulder joint. A transverse incision down to the bone is to be made immediately across the insertion of the deltoid, and a converging longitudinal one, two inches in length, along either border of the same muscle, joining at their lower end the two extremities of the first. The flap thus marked out is to be dissected loose and raised, and the remaining soft parts cut by a circular incision on a line with its base, the retractor applied, and the bone isolated and divided with the saw. From the uncertainty of the assistant's preserving the steady command of the circulation by pressure above the clavicle, it would be safer to seize and tie the extremity of the axillary artery previous to the division of the bone.

The *oval method* has been employed by M. Guthrie for amputation of the arm in its upper third. The mode of making his incision is precisely the same as in his operation for disarticulation of the shoulder joint, with the exception that the apex of the V is to be placed two fingers' breadth below the acromion. In fact most of the various processes for disarticulation might be employed for this amputation.

The *dressings* of the wounds after amputation of the arm is so simple, as not to need description. To obviate the tendency of the muscles to shortening, the arm should be placed on the pillow in a state of half extension.

AMPUTATION AT THE SHOULDER JOINT.

Although the disarticulation of the arm at the shoulder joint was practised by Ledran more than a century ago, it is only within the last half century that it has been admitted as a regular process of the art, and chiefly through its very successful and frequent performance by the great School of Military Surgery, of which Baron Larrey was the head.

Surgical anatomy.—In no amputation is a thorough knowledge of the structures concerned in the operation of greater importance, than in that of the shoulder joint. The articulation differs considerably as to form and arrangement, from all the other joints. The glenoid cavity of the scapula is an oval with a superficial hollow, an inch and three-eighths in length, and an inch broad at its widest part, which is at the inner and lower portion. The head of the humerus is nearly hemispherical, about an inch and three-quarters in diameter, and is rather applied against than fitted to the socket of the scapula, in which not more than one-third of the circumference of the head of the bone can be at one time received. The depth of the glenoid cavity in the recent state is about a quarter of an inch, and its face is presented outwards and slightly forwards and upwards. Half an inch above the top of the glenoid cavity is found a sort of arch or roof, formed by the acromion and coracoid processes, and the strong ligament which is stretched between them. This arch projects more than an inch and a quarter in front of the glenoid cavity, and protects the anterior and part of the lateral surfaces of the joint, covering as it does at least one-third of the circumference of the articulation, and passing back about a quarter of an inch more on the posterior and external than on the opposite surface of the joint, in consequence of the sloping form of the base of the acromion process. The length or base of this arch is full two inches and a half. When

the arm is close by the side, there is a distance of nearly an inch between the greater tuberosity of the humerus and the point of the acromion. When it is elevated, the tuberosity is brought up immediately under the acromion, close to the margin of the glenoid cavity, and more than an inch of the articular surface of the humerus projects on the opposite side beyond the glenoid cavity, between the *teres minor* and *subscapularis*, pushing before it the capsule which is there thin and weak. At the anterior and internal side of the joint, between the tendons of the *subscapularis* and the *supra-spinatus*, the capsule is also thin and feeble. At the outer side the capsule does not descend lower than the upper

margin of the tuberosities; but on the inner it descends, or may readily be depressed, for a quarter of an inch below the line of the neck of the humerus. Above, the capsule is not only attached to the margin of the glenoid cavity, but also to the outer edge of the coracoid process, by a strong band of accessory fibres, called the coraco-humeral or accessory ligament. If we roll the arm outwards we put these fibres on the stretch, and give them the appearance of a band going to both the tuberosities, but especially to the outer. This renders the coracoid process really a part of the articulation. It will appear from this that the strength of the capsule is principally at its anterior and outer portion, the part upon

PLATE XXXIX.—AMPUTATION AT THE SHOULDER JOINT—AT THE UPPER THIRD OF THE ARM.

(Figs. 1, 2, 3.) AMPUTATION OF THE LEFT SHOULDER JOINT. (*Process of Lisfranc.*)

Fig. 1.—*a.* Hand of an assistant compressing with the end of the middle finger the subclavian artery as it passes over the first rib,—the thumb taking a support at the same time from the posterior part of the shoulder, so as to steady the trunk of the patient.

b. Left hand of the surgeon grasping the arm so as to place it in the requisite positions during the operation.

c. Right hand of the surgeon passing the long double-edged catling in order to form the outer and posterior flap.

The knife has been entered in front of the posterior angle of the armpit, and passed up between the head of the humerus and the belly of the *deltoid*. The point has then been lowered in order to open the capsule of the articulation, and again raised so as to be brought out through the triangular space formed at the top and front part of the shoulder, by the coracoid process, the acromion process, and the clavicle. The point and edge of the knife are subsequently to be brought downwards, so as to cut the outer and posterior flap, which is immediately to be raised by an assistant.

(*Fig. 2.*) FORMATION OF THE INTERNAL AND POSTERIOR FLAP.

The blade of the knife has been carried into the articulation through the wound in the capsule made by the puncture as shown in *fig. 1*, and brought round so as to divide the remains of the capsule, and shave the inner side of the neck of the bone. At this stage of the process, which is that shown in the drawing, an assistant grasps the axillary vessels between his thumb and fingers (*d*). The surgeon then completes the section of the flap with the knife (*f*), and with his left hand effects the necessary movements of the limb.

(*Fig. 3.*) SURFACE OF THE WOUND SHOWN AFTER THE COMPLETION OF THE OPERATION.

The glenoid cavity, with half of its capsule about it, is seen in the apex of the wound. The anterior flap is formed by the pectoral muscle, the heads of the biceps, the coraco-brachialis, the *latissimus dorsi*, the *teres major*, and the rotator muscles of the joint. The posterior and outer flap is formed by the *deltoid* alone. The arteries have been seized and tied.

g. Axillary artery tied at the point at which it takes the name of brachial.

h. Inferior scapular artery.

i. Posterior circumflex.

(*Fig. 4.*) AMPUTATION AT THE UPPER PART OF THE ARM. (*Process of Sabatier.*)

The operation is shown near its completion. A flap has been cut at the external and upper part of the arm through the substance of the *deltoid*, the soft parts on the inner side have been divided by a section downwards and inwards, and the saw is shown applied upon the bone.

a. Left hand of the surgeon sustaining the inferior part of the arm.

b. Artery pad applied by an assistant to compress the subclavian artery over the first rib.

c. The other hand of the same assistant, by the aid of a compress raising the flap out of the way of the saw (*e*).

d. Line of the horizontal section of the soft parts downwards and inwards on the side of the axilla.

Fig 2



Fig 1

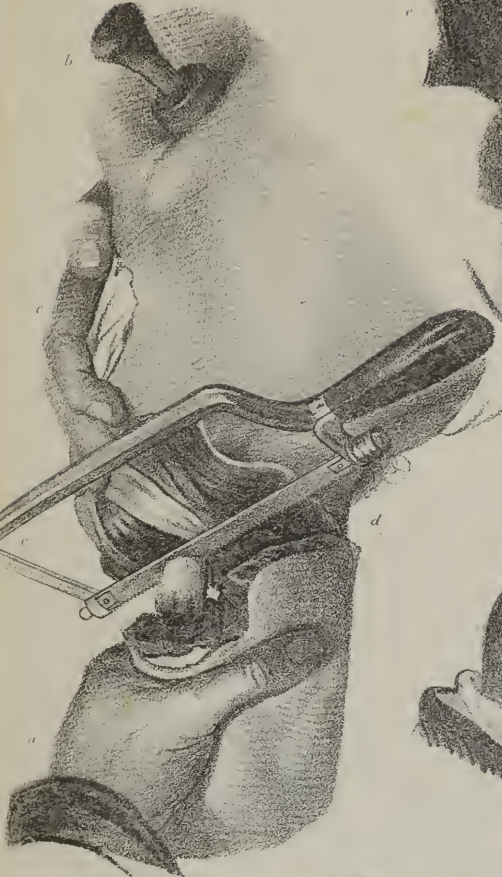
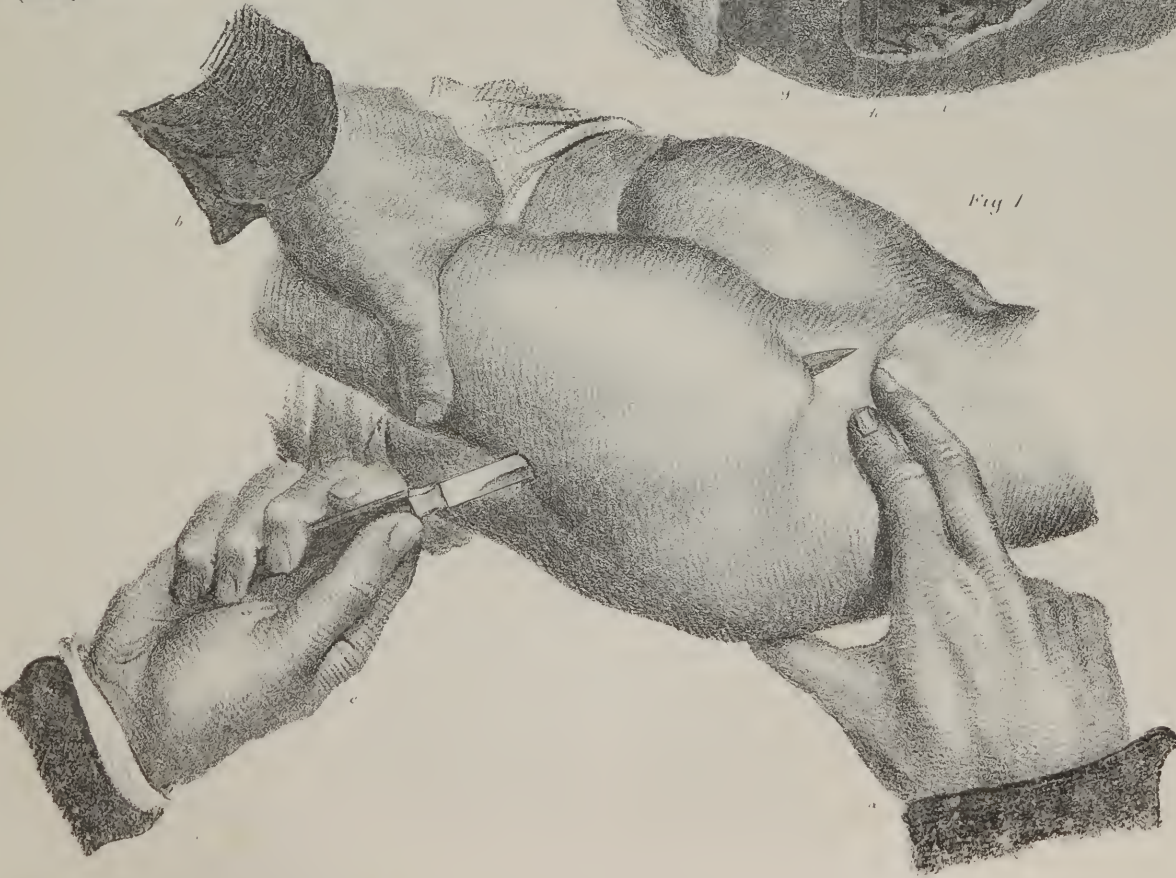


Fig 3



Fig 1



which the point of the knife is first to cut in the process for disarticulation. The articular tendons also offer the greatest resistance in the same position; those of the supra and infra-spinatus and the teres minor, occupying the outer semi-circumference of the joint, and which by rotating the arm strongly inwards may be brought forward so as to come readily under the action of the knife. In front there is but one tendon—that of the subscapularis;—rotation in the opposite direction does not so much influence this tendon, and it is therefore usually found the most troublesome to divide.

The projection of the acromio-clavicular arch makes the principal difficulty of the articulation. In several of the processes, the point of the knife must be passed under this projection, as though it was going to pierce the scapula, in order that it may divide the external rotator tendons which are lodged below the arch. This arch, it must be recollected, forms an irregular osseous interval open in front, bounded by the coracoid process on its inner side, by the acromion on its outer, and the neck of the scapula behind; the interval, which is quadrangular and an inch in extent in all its directions, is occupied by the coraco-acromial ligament, which readily admits the passage of the point of the knife. It may be necessary to observe, that from the projection of this arch, unless the integuments be divided at least three fingers' breadth below the pectoral border of the armpit, the sides of the section will not meet after the disarticulation so as to form a linear wound. The stump of the shoulder is more thickly covered with the muscular structure on the back surface than the front, and if two flaps are formed with the superior angle at the acromion, the posterior will consequently be much larger than the anterior. The acromion and coracoid processes remain for a long time unossified;—a fact which is to be remembered, as it facilitates the disarticulation of the arm in young subjects.

The circular, flap, and oval methods, have all been employed in amputation at this joint, and the processes have been so multiplied, that more than twenty may be enumerated: those entitled to the most favour only will be given. In each case, pressure is to be made upon the subclavian artery above the clavicle with the thumb, the compressor of Bourguery, the handle of a large key, or a boot hook; but since, as has been before observed, it is exceedingly difficult to maintain a thorough command of the circulation, an intelligent assistant should always be prepared to seize the artery either before or at the moment of its division.

Circular method.

This method, which was employed by Alanson in 1744, has been advantageously modified by Græfe, Cornuau, and Sanson, and is well suited to cases where there is much emaciation, or the muscular system is but little developed.

Process of Sanson. (Pl. XL. fig. 1.)—The patient is to be put in a sitting posture. One assistant compresses the artery above the clavicle, and another, placed on the side opposite to the limb affected, passes one arm in front and one behind the trunk, so as to grasp the top of the shoulder with both hands, and draw backwards the skin, especially that of the armpit, as strongly as possible. The surgeon, standing in front of the patient if he operate on the right arm, and behind for the left, grasps the limb with the left hand, and raises it nearly to the horizontal position. He then

passes his knife under the limb, so as to rest its edge over the tendons of the armpit, at the distance of an inch and a half below the point of the acromion, and divides with a single circular incision all the soft parts down to the bone; these are immediately to be separated from the head of the humerus so as to expose the joint. He next cuts with a semicircular incision the rotator, tendons and the capsule, draws the arm downwards, and carrying the knife through the joint, turns it around the head of the bone, which he detaches from its socket by dividing the posterior and lower portion of the capsule. This process is very rapid when well executed, but in fleshy subjects, does not leave sufficient integument to cover well the point of the acromion; and if the arm be raised too high during the first part of the operation, leaves a wound too extensive on the side next the thorax. There is also great danger that excessive hemorrhage may occur from the divided vessels, in consequence of the difficulty of making effectual compression of the artery above the clavicle. The following process, though more tedious in the execution, is therefore entitled to a preference.

Process of Cornuau.—The arm disposed as above directed, the surgeon divides the integuments by a circular cut four fingers' breadth below the point of the acromion. The skin being still further drawn upward by an assistant, he divides by a single cut the soft parts on the anterior, outer and back parts of the limb—from the coraco-brachialis muscle to the tendon of the latissimus dorsi, or from the latissimus to the coraco-brachialis, according as it be the left or right arm—leaving the axillary artery untouched. The divided muscular mass is then to be loosened and raised, the rotator tendons and the capsule cut, and the head of the humerus luxated backward. The knife is next carried round the head of the bone, so as to shave the inner side of its neck. An assistant passes his thumb or forefinger into the wound so as to grasp the artery between them, and the surgeon detaches the limb, by cutting out into the armpit so as to complete the circular incision. If difficulty should occur in opening the joint, in consequence of the length of the integuments below the acromion, they may be split up, as was originally directed by Alanson.

Dressing.—The axillary, the posterior and anterior circumflex arteries, and the acromial, are to be tied in succession. The lips of the wound are to be brought together in a vertical line, and secured by adhesive straps and an appropriate bandage.

Flap method.

The processes by this method are the most numerous, and have been arranged by Velpeau into two classes, according as the flaps are cut from without inwards, or from within outwards.

Process of Ledran. Single axillary flap.—The patient is to be seated in a chair, and the arm held horizontally. The surgeon divides transversely, two fingers' breadth below the acromion, the deltoid and the two heads of the biceps muscle; then, lowering the arm, he continues the incision so as to cut the outer part of the capsule and the rotator tendons, and carries the knife through the articulation in order to bring it down on the posterior part of the neck of the bone. A temporary ligature is then passed with a needle round the bundle of vessels in the axilla, and the knife is brought down so as to detach the limb by cutting a flap three to four inches long on the posterior and internal side of the

shoulder, in which are comprised the great vessels and nerves. It is difficult to retain the large internal flap sufficiently well elevated to cover the acromio-clavicular arch; this process is therefore justly abandoned, except in cases where, from the destruction of the soft parts on the exterior of the shoulder, no other could possibly be applied.

Process of Lafaye. External and superior flap, formed from the deltoid.—A transverse incision down to the bone is made across the deltoid, five fingers' breadth below the acromion. Two other deep incisions nearly vertical, converging a little below like the margins of the deltoid, one on the internal and anterior surface, the other on the external and posterior, are dropped upon the extremities of the first. The flap is then to be dissected from the bone and raised by an assistant, the capsule opened, and the head of the bone luxated upwards. The axillary artery is next to be denuded and tied at the inner margin of the wound; the surgeon then brings down the knife so as to divide the soft parts on the interior of the bone upon a level with the fold of the armpit.

Grosbois and Dupuytren modified this process by elevating the arm at a right angle with the trunk, raising the mass of the deltoid with the left hand, and pushing a double-edged knife between the head of the humerus and the acromio-clavicular arch, so as to cut from within outwards an external superior flap of sufficient length. The flap is to be raised by an assistant, so as to expose the joint,

and the surgeon, grasping the arm with the left hand, approaches it to the trunk, and rolls the elbow inwards so as to extend the rotator tendons. These he divides with the knife, and enters the articulation under the acromion process. He then rolls the elbow so as to turn the head of the bone outwards, while the knife, pressed in the opposite direction, cuts the inner portion of the capsule and the tendon of the subscapularis. The head of the bone is now to be luxated outwards, and the knife slid down upon its neck. The surgeon then pauses for a moment, till the assistant, who has raised the flap with one hand, grasps the axillary artery with the thumb and fore finger of the other, introduced—one into the wound—and the other into the cavity of the axilla. The knife is finally carried downwards so as to cut outwards at the axillary borders, inclining it however a little forwards, in order to make the flap pointed in front, and leave the whole hollow of the armpit remaining on the stump.

Langenbeck and Onsenoort perform the operation in a manner similar to that just described, with the exception that they cut the flap from without inwards, at a single sweep with a knife curved on the flat.

Remarks.—The single flap formed out of the deltoid by these various processes, falls after the operation on the glenoid cavity, and effectually covers the arch above the socket. But the flap is thin at its base, and the muscular tissue of which it is composed is slow to unite with the subjacent parts; it wrinkles and con-

PLATE XL.—AMPUTATION AT THE SHOULDER JOINT.

(Fig. 1.) CIRCULAR AMPUTATION ON THE RIGHT SIDE. (*Process of Sanson.*)

The integuments have been firmly drawn up by an assistant towards the joint, and the amputation knife, which has been applied over the insertion of the armpit tendons, is seen as it is brought round to finish the circular section of the skin and soft parts down to the bone. The right hand of an assistant (*a*) applies the artery pad upon the subclavian as it passes over the first rib. The hand of another (*b*) retracts the soft parts towards the shoulder. The surgeon sustains the limb with his left hand (*c*) while he makes the circular sweep with the knife (*d*). The head of the humerus is then to be separated from the surrounding muscles with the knife, and detached by the division of the ligaments of the joint. After the ligature of the vessels the margins of the skin are to be brought together with adhesive straps, so as to form a linear wound in a direction downwards and slightly inwards.

(Fig. 2.) OVAL AMPUTATION. (*Process of Baron Larrey.*)

The operation is shown near the period of its completion. A vertical incision (*a, b, b*) has been dropped from the point of the acromion. From near the lower end of this, two oblique lateral incisions have been made to the opposite borders of the armpit. The operator has then separated the soft parts with the knife from over the bone (*g*), divided the capsular ligament, and carried his knife through the joint round upon the inner face of the neck of the bone. At this period of the operation, which is the one shown in the drawing, an assistant grasps the axillary vessel in the inner flap between his thumb and fingers (*e*). The operator, sustaining the arm with one hand (*f*), with the other (*h*) finishes the section by carrying the knife (*e*) from the angles of the two oblique incisions through at the inner side of the arm, dividing with the skin the vessels and nerves of the armpit. After the ligature of the divided vessels, the lips of the incision are brought together in a vertical line.

Fig. 3.—*Appearance of the wound after the oval operation of M. Guthrie*, which is but a slight modification of the process of Larrey, and yields the same results.

- i. Glenoid cavity.
- j. Branch of the posterior circumflex artery.
- l. Inferior termination of the axillary, raised on the forceps by the surgeon while an assistant secures it with a ligature.

Fig 2

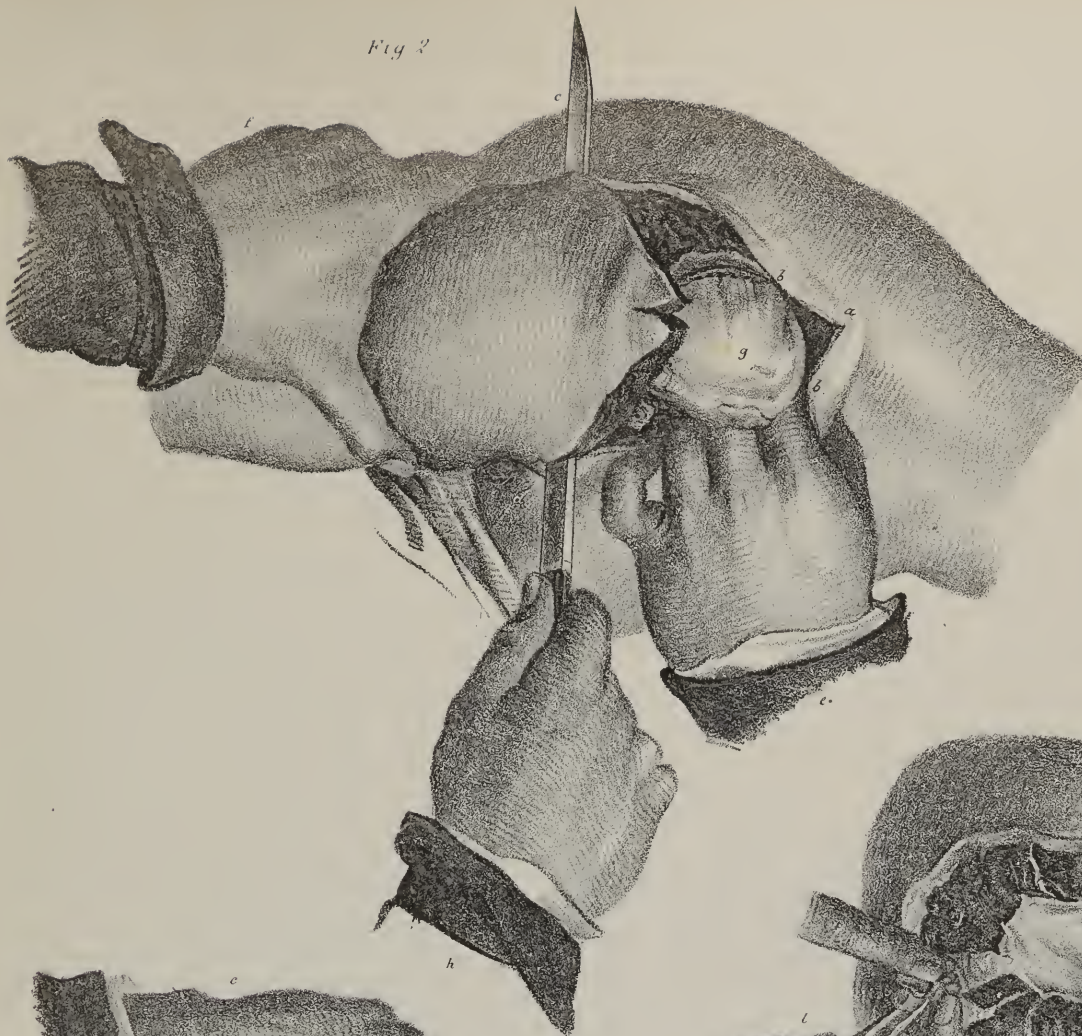


Fig 3

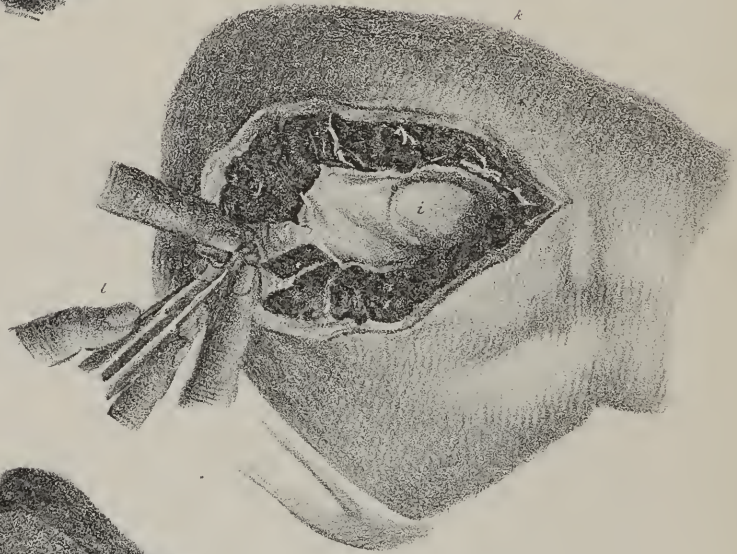


Fig 1



tracts, and, from the difficulty with which it is maintained in contact with the inner and lower margin of the wound, the healing process is rendered protracted. In certain cases, however, of injury of the structure on the axillary side of the joint, it is the method to be preferred. But in circumstances admitting of a choice, the process by a double flap will be found to form a better stump.

Double flap. Process of Sir Charles Bell. One superior and one inferior flap, which unite so as to form a transverse wound.—The artery compressed between the scalmi muscles above the clavicle, and the arm raised, the soft parts are to be divided by a circular incision down to the bone, three fingers' breadth below the point of the acromion. The arm is then to be lowered, and two vertical incisions are to be dropped from the level of the joint down upon the transverse cut—one on the anterior and one on the posterior part of the limb. The flap thus marked out upon the external part of the shoulder is to be dissected from the bone and raised, and the disarticulation accomplished in the usual manner. This process may be considered a good one—it forms regular and well-shaped flaps; but it is not so rapid in its performance as the following, which is commonly preferred to it, though, as it appears to me, upon no very satisfactory grounds.

Process of Lisfranc. (Pl. XXXIX. figs. 1, 2.)—Posterior external and posterior internal flaps.

Left arm.—The patient is seated on a chair, and an assistant placed behind him, ready to raise the flap first formed, and compress the orifice of the posterior circumflex artery with one hand, and the axillary with the other previous to its division in the formation of the second or internal flap. To prevent still further the effusion of blood, the assistant may, during the formation of the first flap, compress with his middle finger the artery above the clavicle, steadying the shoulder with the same hand.

1. The arm is to be raised nearly horizontal. The surgeon standing behind the patient, embraces the stump of the shoulder with his left hand—the thumb resting on the posterior part of the head of the bone, and the ends of the two first fingers over the coraco-acromial triangle; then taking in the other a narrow double-edged knife or catling, which should be eight inches long, and held parallel with the humerus, he enters the point just at the external side of the posterior fold of the armpit, in front of the tendons of the latissimus dorsi, and teres major muscles, with the upper cutting edge a little turned in front, so that the flat of the blade shall lay nearly parallel with the broad surface of the tendons of the above muscles. The knife is then to be passed up along the outer and posterior surface of the humerus, till the point touches the head of the bone; the handle is now to be inclined a little downward to carry the point over the head, and then elevated again with a rocking motion so as to depress the point and open the capsule: now shifting the fingers of the left hand down the arm, he carries the point through in the centre of the space between the coracoid and acromion processes, with the handle raised the distance of two or three inches from the arm. The most difficult part of the operation—the puncture—is now accomplished. Holding the hand nearly immovable, the surgeon next cuts with the point of the knife, inclining it a little from within outwards and from below upwards, so as to disengage the edge from below the acromion, and turn it round the head of the bone.

The knife is now brought down along the external face of the bone, and subsequently inclined towards the skin, so as to cut a posterior external flap three inches long, which includes the tendons of the latissimus dorsi and the teres major. This flap is to be instantly raised by the assistant, and the stream of blood from the posterior circumflex artery, if not arrested by pressure above the clavicle, is to be checked with the thumb and finger of his left hand.

2. The articulation is already laid open, and the outer rotator tendons cut across, if the process as described has been exactly followed. The operator now carries the knife from the outer side through the joint, keeping the handle inclined low, so as to cut from heel to point, and brings it round to the internal side of the head of the bone, which is to be luxated as the knife is slid behind it. The handle is then further depressed so as to become vertical,—the blade is brought down so as to shave the internal side of the bone,—and as soon as sufficient room is made above the knife, the assistant grasps the artery in the thickness of the flap, and the surgeon detaches the limb by cutting out at the level of the armpit, so as to divide the tendon of the pectoralis major and form an internal and posterior flap, of the same length as the preceding.

Right arm.—In the operation for the right arm, some modification of the process is required, in order to enable the surgeon to employ the knife with the right hand. In forming the first flap, he may stand behind the patient and proceed as in the case last described. Then shifting his position to the side of the patient; and holding the handle upwards, he carries the knife through the joint and forms the second flap. Or if he finds it more convenient, he may form the first flap by entering the knife between the coracoid and acromion processes, and carry it down nearly parallel with the bone till the point emerges under the tendons at the posterior fold of the armpit, and finish the section of the flap by bringing the handle downwards.

This process of Lisfranc is very rapid when skilfully performed; the flaps are well disposed for reunion, and furnish a ready outlet below for the discharges that attend the progress of the cure. The acromion is not always, however, sufficiently well covered, and in young subjects, when the muscles are large and act with force, it is not easy to pass the knife in the space between that process and the coracoid. In the latter case, it might answer to make the puncture at the outer side of the acromion, and divide by a separate incision the external rotator tendons and the capsule, rolling the arm inwards so as to bring them more readily under the action of the knife. But on the whole, this process is inferior to the oval method in regard to the neatness and regularity with which the flaps are formed.

Oval method. Process of Baron Larrey. (Pl. XL. figs. 1, 2.)—The arm of the patient is to be placed nearly in contact with the side of the chest. The surgeon commencing at the point of the acromion, makes a vertical incision three inches long, splitting the deltoid in its middle down to the bone. The arm is now to be raised nearly horizontal. An assistant draws the integument well upward towards the top of the shoulder, and the operator makes two oblique cuts through the soft parts in the form of a Λ reversed, commencing at the middle of the vertical incision;—one, the anterior, is carried downwards and forwards to the

anterior fold of the armpit, so as to divide the pectoralis major very near its insertion upon the humerus; the other—the posterior—downward and backward to the posterior fold of the armpit, cutting in like manner with one sweep of the knife the deltoid, and the insertion of the latissimus dorsi and teres major, leaving untouched the vessels, nerves and integuments of the axillary cavity. The two muscular flaps are then rapidly loosened from the bone and drawn upward by an assistant, who grasps one with each hand, and at the same time makes pressure on the bleeding orifices of the two circumflex arteries. The articulation is now laid bare. The surgeon rolls the arm a little inwards and divides the rotator tendons and the outer half of the capsule by a semi-circular cut; luxates outward the head of the bone; glides around it the knife so as to shave the neck and divide the remaining half of the capsule; and arrests the instrument on a line with the lower angles formed by the two oblique incisions. At this pause in the operation, another assistant introduces his thumb and fore finger—one into the wound, the other into the axilla, so as to compress the axillary artery, the position of which will be manifested by its pulsations. The surgeon then completes the operation by cutting through towards the chest, so as to unite the two oblique incisions at their lower ends. The incision is not, however, to be made directly transverse as if we were to cut the base of a Δ , but sloped a little downward on the arm, in order to leave on the stump a little more than the whole integuments belonging to the axilla. By thus modifying the last step of the operation, we leave the two flaps united below, so that they come well together in the middle line; for when the transverse incision is made in the more common manner directly into the armpit, the integuments are too scant at the lower edge of the wound, and leave a space which has to be filled up by a cicatrix of new formation.

In this process the surgeon stands at the outer side of the limb, and finds it difficult to make both oblique incisions with the right hand. It is better, therefore, as regards one of them, to shift the knife over to the left hand as directed by Baron Larrey. It is not difficult, however, if the surgeon is unpractised with the left hand, to make the second incision with the right—which may be anterior or posterior according to the arm on which he acts—by dividing the parts from the skin to the bone and from below upwards; or by passing the knife over the face of the bone from above downwards, puncturing the skin under the tendons, and cutting outwards. In making the anterior oblique incision, the operator, if he is not sure of his hand, may pass his fingers into the axilla, to avoid all risk of a premature division of the great artery, which lies but a little distance from the anterior tendons of the armpit.

A slight modification of this process of Larrey has been made by Guthrie and Scoutetten. They both reject the vertical incision. Guthrie begins the two oval incisions at the point of the acromion, cutting first only through the integuments, which are then to be drawn upwards, and the muscles divided by a second incision on a line with the retraction. Scoutetten begins the oval incision at the same point, cutting at once down upon the bone from the joint to the armpit tendons, and carrying the knife lightly across so as to divide *merely* the skin of the armpit, and unite the two oblique incisions below. The subsequent steps of the operation in each case are the same as in the process of Larrey.

Of the various processes described, the oval and the circular are those unquestionably which offer the greatest facility in the performance, and afford the most satisfactory results. But the lesions requiring amputation of the arm at the joint are so very various, and so often accompanied with a destruction of the soft parts on one side of the limb, that cases frequently occur in which the single or double flap will be found the only ones admissible, and even these as given, will sometimes require to be varied by the ingenuity of the surgeon, in order to get for the stump the best covering possible out of the uninjured soft parts.

The process of Barron Larrey, which has been the most employed, has, according to Sedillot, been attended with success in ninety out of a hundred cases.

Dressing.—For the prevention of hemorrhage the ligature *en masse* of the vessels previous to the operation, as practised by Ledran, is now utterly laid aside, the surgeon trusting to the plans already detailed for the stifling of the hemorrhage until the limb is removed and the surgeon can secure the bleeding orifices on the face of the stump. The axillary artery is to be the first tied, next the circumflex and such other vessels as throw out blood in a jet. The ligatures are to be brought out at the lower angle of the wound, and the flaps approximated with adhesive straps;—occasionally the interrupted suture will be found useful in the adjustment of the flaps. Pressure should be made with a bandage from the trunk towards the stump, so as to prevent purulent accumulations. A particular bandage (*fascia pro excisione humeri*) will be found useful to effect this object. It is to be two yards and a half long and three quarters wide, slit open in the middle so as to receive the arm and come up to the shoulder of the opposite side, and then split into four tails which are to be brought round the stump.

AMPUTATION OF THE SHOULDER BLADE WITH THE ARM.

In cases of extensive traumatic injury, caries, or malignant diseases, it may occasionally be necessary to remove a part or even the whole of the shoulder blade with the arm. Parts of the shoulder, as the acromion process, the neck of the scapula, and the outer end of the clavicle, have been many times successfully removed; and Cuming, of Jamaica, and Professor Mussey, of Cincinnati, have been equally fortunate in removing the shoulder blade entire. But the success has been chiefly confined to instances of traumatic injury. The mode of operation must vary according to the nature of each particular case, and no general formulæ can be established. There will be in fact two operations—one for the resection of the shoulder, and one for the disarticulation of the arm. The resection of the shoulder bones should in general precede the latter. The methods for resection which have already been given, will only require to be so modified that the division of the soft parts shall be made in order to facilitate as much as possible the subsequent operation upon the joint.

OF THE LOWER EXTREMITIES.

As in the upper extremities, amputation may be performed in the lower, either in the continuity of the bones or at the joints.

The importance, however, of preserving the greatest possible length of the limb, by operating under certain circumstances for this purpose through the joints, is not so imperative in regard to the lower extremities as the upper, and must indeed be held as subsidiary to another object—that of affording the greatest facility for the adjustment of the means of artificial support.

The shortness of the toes, their minor importance as compared with the fingers, and the risk of the stump becoming irritated against the boot, render it customary, with the exception of the first, to amputate them at their metatarso-phalangeal joints rather than between the phalanges. The great toe, which forms an important point of support to the foot, should be preserved as long as possible, and may be amputated by processes similar to those of the fingers, either through its phalangeal joint or in the continuity of the phalanges. If amputated at its metatarsal joint, the two sesamoid bones on its under surface may be left attached to the flap. The amputation of the toes at their metatarso-phalangeal joints, separately or all together, and that of the metatarsal bones through their continuity, is performed by processes so nearly similar to those for corresponding bones of the hand, that it would be useless to repeat the description here, and the little differences will be sufficiently explained by reference to Plates XLI. and XLII., in which the operations are shown. It may be observed, however, that there is more objection to the removal of the metatarsal bones when it can possibly be avoided, as it necessarily diminishes the breadth and solidity of the support furnished by the foot. This is particularly the case in reference to the first metatarsal, the whole or a part of which should always be left whenever the nature of the disease will admit of it. If it become necessary to remove this latter bone at its metatarso-tarsal joint, the knife must be used with caution at the inner side of the base, for fear of wounding the anterior tibial artery, which dips down at this point to reach the sole of the foot. If this vessel should be wounded, it may be secured with a ligature, and usually without much difficulty. In spite of every care as observed by Professor Ferguson, troublesome bleeding will sometimes occur at the deep-seated corner of the wound, which can only be arrested by a graduated compress, made by first introducing small and then larger pieces of lint, and securing the whole by compression with a bandage. There is also, as I have observed in one instance, and which has been noticed by the same writer, a tendency in the adjoining toes, from the want of support at their inner margin, to curve inwards, so as to become a source of inconvenience by pressure against the boot; to obviate this inconvenience I have been obliged to remove the second toe at its root.

1. AMPUTATIONS OF THE FOOT.

AT THE METATARSO-TARSAL JOINTS.

Since the time of Sharp and Hey, the partial amputations at the transverse joints of the foot have attracted considerable attention as a means of saving the heel and ankle, and preserving the length of the limb, without producing any deformity that would not be well hidden in a boot. But from the imperfection

of the processes employed, and the imperfect study of the irregular structure of the joints, considerable difficulty was encountered in the disarticulation in the few instances in which it was attempted, and the saw was usually resorted to for the detachment of the bones.

To Lisfranc we are mainly indebted for an accurate description of the parts concerned, as well as for the precise details of the operation, which have removed nearly all the difficulties in the way of its performance.

The growing sense of the importance of saving as much as possible of the body of the foot, has induced surgeons latterly to restrict the operation at this joint to cases in which the posterior extremities of the metatarsal bones are diseased, justly preferring to divide the metatarsus in its continuity with the saw, when by so doing a healthy portion of it can be preserved in connection with the tarsal bones.

Surgical anatomy.—The posterior extremities of the five metatarsal bones are articulated with the cuboid and the three cuneiform. The line of junction is transverse, but irregular and intricate, forming a curve, which terminates nearly an inch more in front on the inner than the outer side. On the external side, the commencement of this line is well marked by the projection at the posterior part of the metatarsal bone of the little toe, which can readily be distinguished by carrying the finger back along its outer side; immediately behind this projection is the depression, indicating the joint which separates the metatarsal bone from the cuboid. By abducting the foot, we may also either see or feel, according to the state of the parts, the tendon of the peroneus tertius muscle, which is inserted on the tuberosity.

The *internal* end of the articular line is next to be ascertained. The three following indications will serve for this purpose, some one or more of which, whatever may be the state of the parts, it is always possible to apply.

1. From the middle of the tuberosity of the fifth metatarsal bone, draw a straight line directly across the back of the foot. Three-quarters of an inch in front of the internal end of this line, will be found the joint between the internal cuneiform bone and the metatarsal of the great toe, which forms the inner end of the articular line in question.

2. By passing the finger backwards along the internal and inferior side of the first metatarsal, we feel first the tuberosity at the end of this bone, then a little depression behind it, and lastly a second prominence which belongs to the cuneiform bone. The depression between these prominences marks the line of the joint.

3. By carrying the finger from behind forwards, along the internal border of the foot, a projection is felt just an inch in front of the malleolus, formed by the scaphoid bone. An inch and a quarter in front of this, is the inner edge of the joint.

In some rare instances, the tuberosity of the fifth metatarsal bone has been found extending further backwards, so as to be articulated with the side of the cuboid bone, and increase the length of the curve on the outer side of the foot.

The *direction of the articular surfaces* is as follows: between the *fifth metatarsal* and the cuboid bones, the interline runs first in the direction of the inner edge of the metatarso-phalangeal joint of the great toe, then turns more inwards in a line towards

the middle of the first metatarsal bone, and is next directed nearly transversely across the foot, to form the line of articulation of the *fourth metatarsal* with the cuboid; the whole of the curve thus described round the face of the cuboid, is about an inch in length, its internal end being about a third of an inch in front of its external.

The articulation of the *third metacarpal* with the outer cunei-

form bone is about half a line more in front, and runs transversely. The end of the *second metacarpal* bone, which is the most intricately articulated, falls about the sixth of an inch further back, and is connected nearly transversely with the middle cuneiform. It is also articulated on the sides with the other two cuneiform bones; the internal one projecting about a third of an inch more in front than the middle bone, so as to leave the end of the second

PLATE XLI.—AMPUTATIONS ON THE FOOT.

Fig. 1.—Representation of the linear wound left after the oval amputation of the first and third toe at the metatarso-phalangeal joints.—The first steps of this operation are shown at *fig. 2*.

(*Fig. 2.*) AMPUTATION IN THE CONTINUITY OF THE FIVE METATARSAL BONES.

Having cut a dorsal and plantar flap—the latter being much the longer of the two—from the surface towards the bone, the surgeon inclines the foot, as shown in the drawing, so as to cut the interosseous muscles in the arch of the foot, which from their deep situation have not been included in the plantar flap.

- a.* One hand of an assistant, steadying the leg.
- b.* The other hand of the same assistant, sustaining the foot, and at the same time securing the ends of the compress (*c*), with which the plantar flap is drawn back out of the way of the knife.
- d, e.* Hands of the operator, who is about to divide the interosseous muscles with the knife.

(*Fig. 3.*) AMPUTATION IN THE METATARSO-TARSAL ARTICULATION. (*Mixed process of Baudens.*)

A dorsal and plantar flap have been formed, as described in the text. The joint between the internal cuneiform and the first metatarsal bone has been opened with the knife, upon a level with which, the four metatarsal bones of the smaller toes have been divided with the saw, so as to give a regular surface to the stump.

(*Figs. 4, 5.*) AMPUTATION THROUGH THE METATARSO-TARSAL JOINTS. (*Process of Lisfranc.*)

Fig. 4.—Opening of the joints on the dorsal surface.—A semilunar flap of skin has been cut on the back of the foot, and the extensor tendons divided somewhat nearer the line of the joints. The articulation of the cuboid with the two outer metatarsal bones (*a*), and that of the internal cuneiform with the first metatarsal (*b*), have been opened with the knife. The knife is shown as applied for the purpose of detaching the head of the second metatarsal bone from the mortise in which it is lodged.

- c.* Hand of an assistant, sustaining the leg.
- d.* Left hand of the surgeon, grasping the extremity of the foot with the palm under the sole. The thumb (*e*) and the fore finger (*f*) are applied upon the tuberosities of the first and fifth metatarsal bones, serving as a guide to the operator in determining the limits of the incision for the dorsal flap (*g*).
- h, i.* Knife employed in the right hand of the surgeon, the point of which is plunged between the head of the second metatarsal bone and the internal cuneiform, in order to divide the internal interosseous ligament. At *h* the knife is entered at an angle of 45 degrees, till it divides the ligament and the point is arrested against the bone. The dotted line (*i*) indicates the track of the handle of the knife in effecting the division of the ligaments of this joint, which is the most difficult part of the operation.

Fig. 5.—Formation of the plantar flap.—The stage of the operation shown is that where, after having separated the articular surfaces, the surgeon insinuates the knife between the internal cuneiform and first metatarsal bones, to begin the section of the plantar flap. The shape of this flap is to be the same as that shown at Plate XLII. *fig. 3*. The surgeon, with his left hand at *a*, depresses the points of the toes, while he employs the knife in his right (*b*).

(*Fig. 6.*) OVAL AMPUTATION IN THE CONTINUITY OF THE FIRST METATARSAL BONE.

The oval incision of the skin having been made, the bone isolated, and the soft parts drawn away from the bone by the aid of a compress, the surgeon takes the toe in his left hand (*a*), while he makes the section with the saw in his right (*b*).

Fig 2

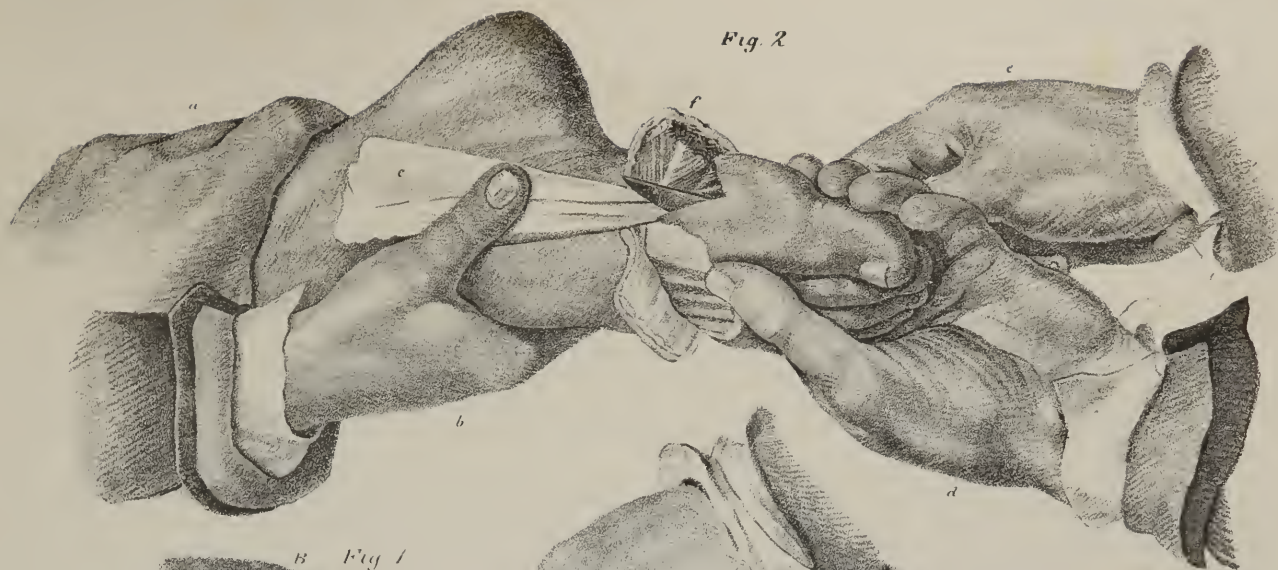


Fig 1



Fig 5

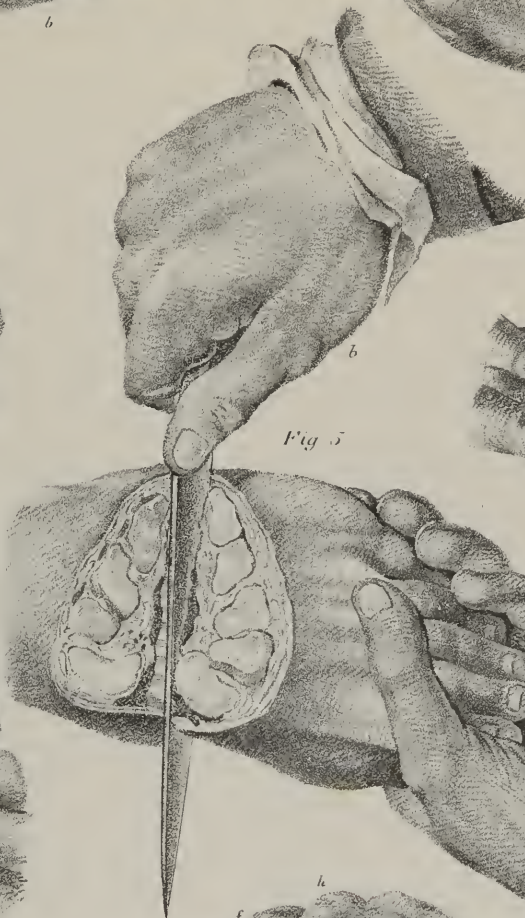


Fig 3

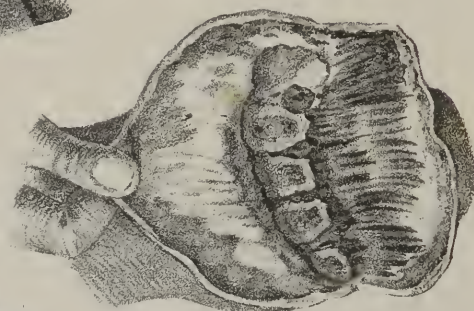


Fig 6

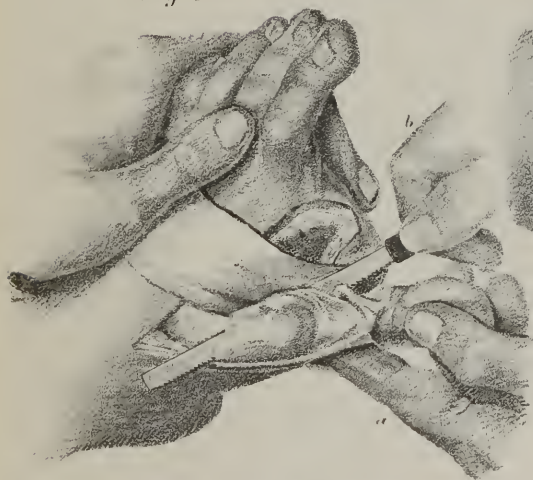
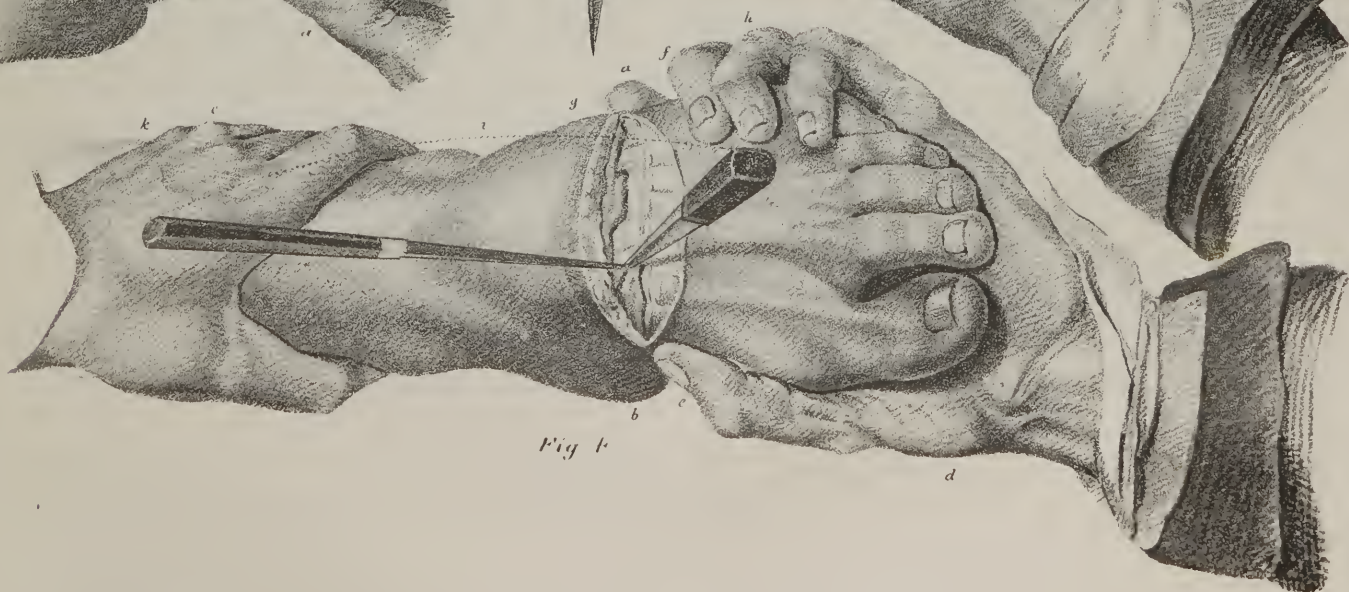


Fig 4



metatarsal lodged in a mortise, shelving on the sides, a little more than half an inch broad at its base on the middle cuneiform, a sixth of an inch wide on its outer side, and a third of an inch at its inner. The articulation of the *first metatarsal* with the internal cuneiform, is about a quarter of an inch in front of the preceding, and slopes in the direction of a line passing from its internal edge to the middle of the fifth metatarsal bone.

All the metatarsal bones are articulated with the others upon the sides, with the exception of the first. On the plantar surface, the metatarso-tarsal joint is much more narrow than on the back, on account of the arched form of the foot, and the second cuneiform is found almost entirely concealed by the first.

The *ligaments which connect the bones together* are found on their dorsal, plantar and lateral surfaces, and do not require to be particularly studied, as they are readily divided with the point of the knife by following the line of the joint. There are three interosseous ligaments, the position of which should be well known. The internal one of these is very strong, and is called the *key of the articulation*. It runs from the external face of the first and from the internal face of the second cuneiform, and is inserted upon the corresponding faces of the first and second metatarsal bones. The second or middle interosseous arises from the external face of the second cuneiform and the internal face of the third, and is inserted upon the corresponding surfaces of the second and third metatarsal. The third or external interosseous ligament is connected in a similar manner with the adjoining faces of the external cuneiform and cuboid behind, and the third and fourth metatarsal in front. It will therefore be seen that the mortise at the head of the second metatarsal, which is the cause of the greatest difficulty in the operation, lodges ligaments upon its sides, and leaves room, as shown by Lisfranc, for their easy division by the introduction of the point of the knife.

Anchylosis has occasionally been observed in some of the joints. If this is firm or extensive, the bones will have to be divided with the saw. If, as is more commonly the case, it is limited to the mortise, the head of the second metatarsal may be divided so as to form a straight line with the ends of the two cuneiform bones upon its sides.

Process of Lisfranc. Plantar flap. (Pl. XLII. fig. 4, 5.) *Left foot.*—The patient is to be placed on his back; and the foot, half flexed, projecting over the bed, and resting on the heel, is to be steadied by an assistant who grasps it above the malleoli. The surgeon, taking the foot in his left hand with the palm applied under the sole, and the thumb and fore finger just half an inch in front of the two extremities of the articular line, and marking out in his mind or with the handle of the scalpel the course of the articulation, makes a semicircular division of the integuments, with a narrow, straight knife, half an inch or more in front of the line of the joint, commencing and terminating at the two extremities of the articular line. The skin, loosened if necessary with the knife, is now to be drawn backwards by an assistant, and the extensor tendons and the remaining soft parts divided down to the bones, as nearly as possible on a level with the joint. Without changing the position of the left hand, the surgeon carries the point of the knife upon the external side of the joint, and cuts the dorsal ligaments, with a slight sawing motion, along the curved line of the articulation of the last two metatarsal bones,

until the instrument is arrested against the outer edge of the third cuneiform bone. The point is now to be turned so as to advance a line in front, and then carried across the transverse articulation of the third metatarsal with the middle cuneiform bone. The knife is next to be shifted to the inner side of the foot, and the point alone entered as before (the blade held nearly vertical) between the adjoining surfaces of the first metatarsal and the inner cuneiform, separating the dorsal ligaments in the direction of the joint towards the middle of the fifth metatarsal bone, till the knife is arrested against the second metatarsal. The head of this latter bone, locked within the three cuneiform by strong ligaments, is next to be loosened by inclining the handle of the knife towards the toes, with the edge towards the ankle, so as to form an angle of 45 degrees; then pushing up the point along the inner edge of the mortise till it is checked against the middle cuneiform bone, and raising the handle vertically, the first interosseous ligament is divided with the edge. Now, raising the point and turning the edge of the knife outwards, follow the mortise round so as to divide its ligaments, depressing at the same time the anterior portion of the foot, in order to raise the bases of the metatarsal bones and make the line of the joint conspicuous. The articulations are all now opened; luxate next the whole metatarsus backwards, by shifting the thumb forwards upon the dorsum, pushing with it strongly downwards, while the fingers on the sole press upwards against the base. The remaining interosseous and plantar ligaments are then to be divided through the gaping joint with the point of the knife. By another effort, as before, complete the luxation, shave with the point of the knife a part of the under surface of the metatarsal bones, so as to gain room behind them to lay the blade and turn it round the tubercle of the last metatarsal bone. We then finish the operation by holding the sole of the foot somewhat obliquely, so as to shave the under surface of the metatarsal bones, (which is most concave on the inner side,) till the edge of the knife comes in contact with the sesamoid bones of the great toe. Then, turning the foot still more upon its side, cut obliquely through the skin, from the outer to the inner margin of the foot, in order to form the plantar flap, which should be convex in the middle, two inches long at the inner, and a little more than an inch at the outer edge.

Right foot.—For the right foot the process is precisely the same, with the exception that we reverse the position of the thumb and finger of the left hand, and finish the division of the plantar flap from the inner towards the outer border. If the first cuneiform bone should be found unusually prominent, or the flap prove too short to cover it completely—a circumstance against which, however, the surgeon should carefully guard—the end of the bone might be removed with the saw.

It is scarcely necessary to say that means must be taken to command the circulation during the operation, either by pressure on the anterior and posterior tibial arteries with the fingers of an assistant, or by the application of a tourniquet to the thigh.

The *dressing* is simple. The bleeding vessels are to be tied; the flaps brought together over the ends of the bones by adhesive straps, and sustained by a roller bandage. The patient should be placed in bed with the leg half bent, and resting on its outer side, so as to facilitate the discharge of any matter that may form in the wound.

Mixed process of Baudens. (Pl. XLII. fig. 3.)—The foot held as in the process last described, enter the point of a double-edged knife under the base of the first or last metatarsal bone, according to the foot on which we act, and glide it across to the opposite side along the plantar surface of the bones, which are to be shaved downwards to form the plantar flap. Unite then the lateral margins of this wound by a semilunar incision over the back of the foot, and dissect up and revert the dorsal flap. Draw back also the plantar flap; divide by a circular incision the remaining soft parts, including the interosseous muscles on the sole; disarticulate the first metacarpal bone from the internal cuneiform, and divide the four smaller ones with the saw in advance of their joints.

This process is more rapid and more easy of performance than that of Lisfranc, leaves a more regular surface, and is entitled to a

preference when the bases of the last four metatarsal bones are not involved in the disease which has called for the operation.

AMPUTATION AT THE MIDDLE TARSAL JOINT.—AMPUTATION OF CHOPART.

Surgical anatomy.—This joint is formed by the os calcis and astragalus behind, and the scaphoid and cuboid bones in front. Two distinct articulations exist—one between the calcis and cuboid bone, and one between the astragalus and scaphoides. The general direction of the joint is transverse, but the bones are not exactly upon the same line when the foot is extended; the calcis then projecting about a quarter of an inch in front of the astragalus. But when the foot is flexed they are nearly on the same level.

PLATE XLII.—AMPUTATIONS ON THE FOOT.

(Fig. 1.) FLAP AMPUTATIONS OF THE FIVE TOES AT THE METATARSO-PHALANGEAL JOINTS.

A dorsal incision, convex forwards, has been made in front of the ends of the metatarsal bones, the skin drawn back and the extensor tendons divided over the line of the joint. The articulations have been opened and the knife is shown in the right hand (*d*) of the surgeon, after it has been carried through the line of the joints, and is about to finish the division of the plantar flap by cutting out at the plantar crease at the root of each of the toes. The surgeon holds the joints of the toes in his left hand (*b*), while an assistant (*a*) sustains the foot.

(Fig. 2.) AMPUTATIONS OF THE TOES.

(A). *Oval amputation of the great toe.*

An oval section of the skin has been made, and the operation is shown as the knife, which has cut the ligaments and entered the joint, is about to detach the phalanx.

On the same foot is shown the appearance of the stump after the removal of the third toe by a double flap. In Pl. XLI. fig. 1, is seen the linear wound formed by the approximation of the adjoining toes after the same operation, as well as that after oval amputation of the great toe.

(B). *Oval amputation of the metatarsal bone of the small toe at its junction with the cuboid.*

The anterior end of the bone is shown drawn outwards with the left hand of the surgeon, while he opens the joint with the point of the knife.

(Figs. 3, 4.) AMPUTATION AT THE MIDDLE TARSAL JOINT OF THE RIGHT FOOT. (*Process of Chopart, modified.*)

Fig. 3.—*Disarticulation.*

The foot is shown properly sustained by the two hands of an assistant.

a. A semi-elliptical incision has been made over the dorsum, the flap (*e*) drawn back, the tendons divided over the joints, and the ligaments cut at the free borders of the two joints. At this period of the operation, the knife (*f*) is shown passing under the posterior end of the scaphoid and cuboid bones to form the plantar flap. The surgeon with his left hand (*b*) grasps the plantar surface of the foot, the thumb (*c*) and fore finger (*d*) being placed on the prominences of the scaphoid and cuboid as a guide to the line of the double articulation.

Fig. 4.—*Formation of the plantar flap.*

g. Hands of an assistant steadying the limb.

h. Left hand of the surgeon depressing the toes, and at the same time forcing up the posterior end of the fragment (on which are seen the scaphoid and cuboid bones), to give room to the knife (*i*) as it forms the plantar flap (*l*).

k. Dorsal flap of integuments.

On the surface of the stump are seen the articular faces of the astragalus and the apophysis of the os calcis. The anterior tibial and plantar arteries (*m*), which will require to be tied, are shown on the face of the wound.

Fig 1

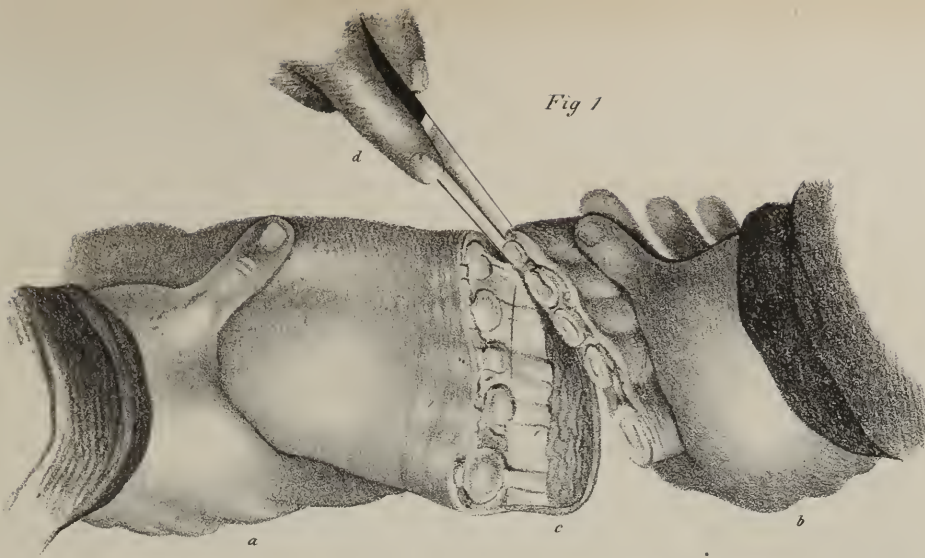


Fig 2

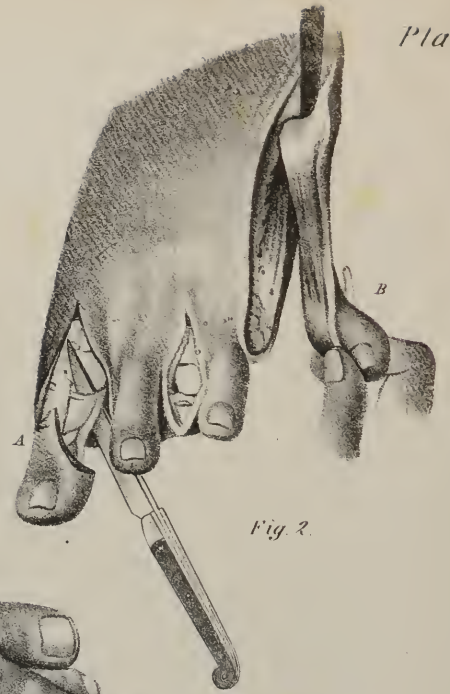


Fig 4

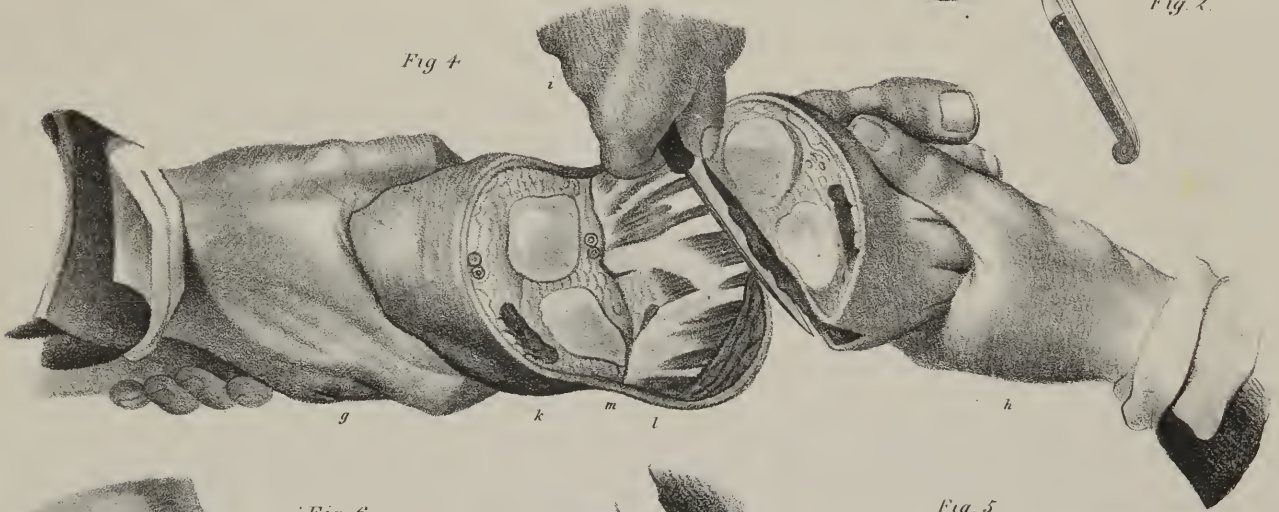


Fig 6

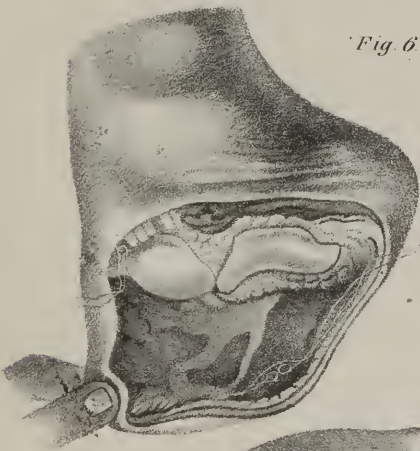
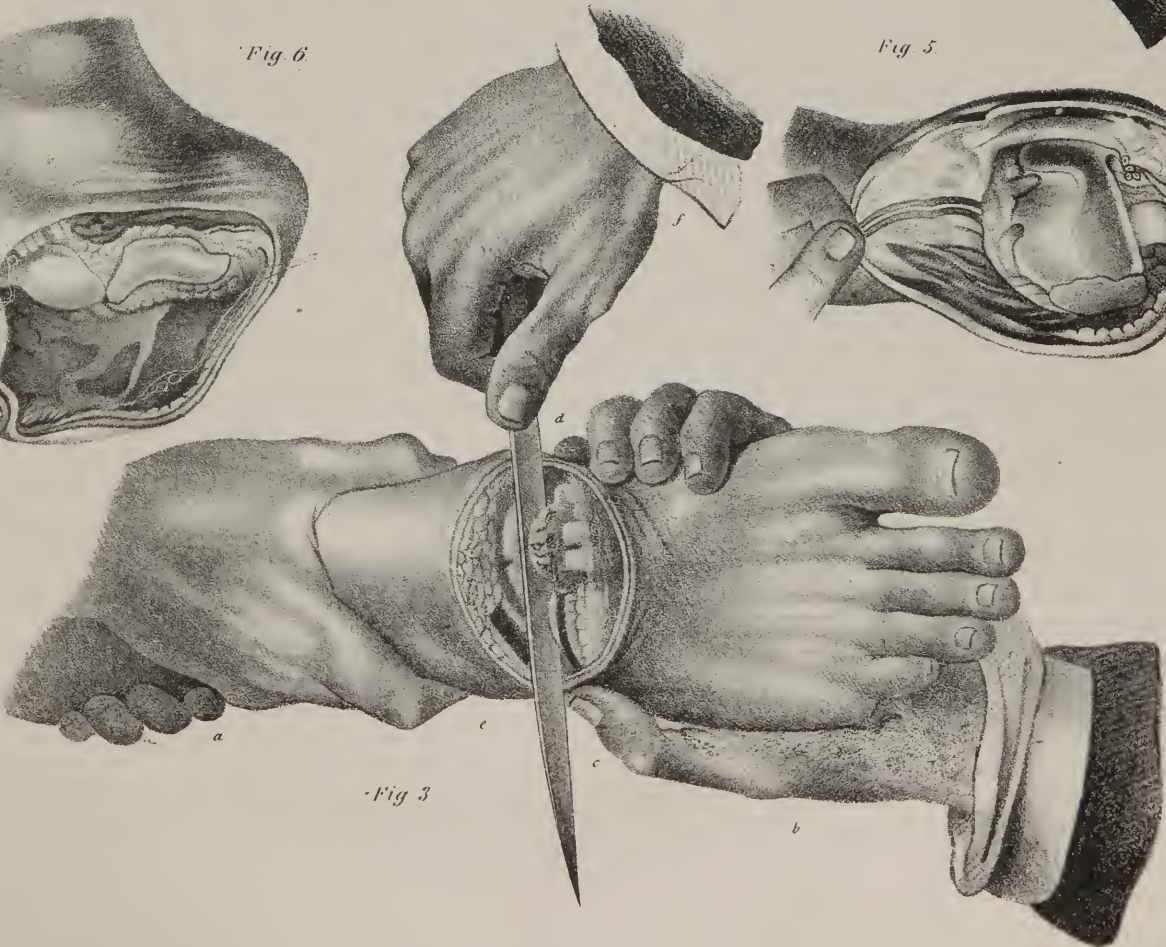


Fig 5



Fig 3



In order to find the internal end of the articulation, trace with the finger the inner border of the foot from the malleolus forwards. The first tuberosity met with, distant about three quarters of an inch from the malleolus when the foot is extended, belongs to the scaphoid bone; and immediately behind it is the joint.

Tracing in the same manner the external border of the foot, the first tuberosity encountered belongs to the calcis. In front of this is the line of the joint, about an inch and a quarter in advance of the external malleolus, and half an inch posterior to the tuberosity of the fifth metatarsal bone.

The ligaments of this middle tarsal joint are loose and easily divided, with the exception of one, that unites the calcis and the outer part of the scaphoid, and which is properly considered *the key of this articulation*. The direction of the line between the os scaphoides and the head of the astragalus, which may be made visible through the skin by strongly abducting the foot, is that of a half moon with the convexity in front. To follow this line from above downwards, so as to divide the parts next the sole, the handle of the knife must be depressed towards the toes. The joint between the calcis and cuboides forms an oblique plane directed from within outwards and slightly forwards. The foot is to be put in the same position and the circulation controlled as in the preceding amputation.

Process of Chopart a little modified.—(Pl. XLII. figs. 3, 4.)—The surgeon places his left thumb and fore finger on the lateral projection of the scaphoid and cuboid bones, and divides, with a semicircular incision over the dorsum—convex forwards and half an inch in front of the joint—all the soft parts down to the bone. He then opens the calcaneo-cuboid joint, and the astragalo-scaphoid, by cutting their dorsal ligaments in succession. Pressing downwards the end of the foot, he next enters the point of the knife at the outer side of the joint in order to divide the strong interosseous, or calcaneo-scaphoid ligament, which forms the key of the joint. The foot, by first drawing it forwards, is now readily luxated upwards. The surgeon then carries the knife through the joint, shaves the tuberosities of the cuboid and scaphoid bones, and those of the first and fifth metatarsal, and cuts out—with the foot turned a little upon the edge—near the heads of the metatarsal bones, so as to form a large plantar flap.

The objection to this process, which has been many times practised, is the great extent of the flap necessary to cover the large surface of bone exposed, the unavoidable narrowness of its

base, and the difficulty of retaining the thick flap so well elevated as not to leave any surface over the edge of the astragalus to unite by granulation.

The following processes are designed to obviate these inconveniences to a very considerable extent, and apply to cases in which the plantar surface is so involved in the lesion, as not to allow of the formation of an extensive flap.

Process of Sedillot. Oval process. (Pl. XLII. fig. 6.)—Begin the operation by making a transverse incision over the external semicircular edge of the tarsus—that is, from over that part of the middle tarsal joint in range with the second cuneiform bone—and then bring the knife round the lower surface of the cuboid to the apophysis, over which is reflected the tendon of the peroneus longus muscle, dividing everything down to the bone in its course. From the upper angle of this incision, make another obliquely downwards so as to cross the middle of the first metatarsal bone; carry the knife round this bone, and continue its course diagonally across the sole to the termination of the first incision over the cuboid, dividing in its track everything down to the bones, but with the handle inclined forwards so as to leave a beveled edge. Dissect from the bones and elevate the large internal oval flap thus marked out, loosen the integument also on the upper and outer part of the foot behind the transverse incision, so that the whole covering of the bones may be drawn backwards by an assistant as far as the middle tarsal joint, the position of which will be indicated by the projection of the head of the astragalus. The articulation is then to be opened as in the process already described, and the knife passed between the bones, so as to complete the separation by dividing the soft parts below, on a line with the base of the plantar flap.

The separation of the plantar flap from the bones may, if the surgeon prefers, after it has been marked out with the course of the knife across the sole, be left for the last step of the operation; the knife, after it has passed through the joint, being carried downwards, so as to shave the under surface of the bones to the line of incision. The anterior tibial and plantar arteries are to be tied, and the flap applied to the ends of the bones, so as to form a linear cicatrix at the outer margin.

Mixed method of Baudens.—The object of this surgeon is to preserve a greater length to the foot by avoiding the removal of the scaphoid, and the posterior half of the cuboid bone, in those cases in which the lesion of the tarsus does not extend further back than

(Fig. 5.) AMPUTATION AT THE ANKLE JOINT. (*Oval process of Baudens.*)

The large oval flap of integument has been traced out and reflected upon the leg, as described in the text, and the stump is shown after the division of the malleoli and the posterior border of the tibia has been made with the saw. The posterior tibial artery is secured with a ligature. The anterior tibial is seen accompanied with its veins on the lower surface of the dorsal part of this flap.

(Fig. 6.) AMPUTATION AT THE MIDDLE TARSAL JOINT OF THE LEFT FOOT. (*Process of Sedillot.*)

The large internal oval, and the small upper and outer flap, have both been dissected loose and reverted, and the foot detached at the joint, so as to show the form of the stump and the kind of covering obtained by this process. Ligatures have been applied to the anterior tibial and plantar arteries.

the cuneiform bones, and the anterior half of the cuboid. The process for the operation is very simple.

A double-edged knife is to be passed across close under the bony arch of the tarsus, from the back part of the tuberosity of the fifth metatarsal bone to the posterior part of the internal cuneiform bone for the left foot, and in a reverse direction for the right. The knife is then to be carried down along the under surface of the metatarsal bones, so as to cut a plantar flap two inches in length. A little behind the termination of this, a transverse incision is to be made through the integuments on the back of the tarsus, and the flap dissected up and reverted as far back as the joint between the scaphoid and cuneiform bones. The surgeon now disarticulates the two outer metatarsal bones from the cuboid, in the manner described at page 161; then on the inner side of the foot opens the joint between the scaphoid and cuneiform bones, and depressing the point of the foot, completes the disarticulation by dividing the interosseous, transverse, and strong plantar ligaments, so as to remove the whole metatarsus and the three cuneiform bones. The projecting end of the os cuboides is then to be sawed off on a line with the surface of the scaphoid bone.

The advantage resulting from this modification of Chopart's process, consists in the preservation of the insertions of the muscles on the scaphoid and cuboid bones,—muscles which serve to keep the stump of the foot flexed and prevent the club foot deviation, too apt to result in the former process, from the unresisted action of the sural muscles.

Each of these processes, it may be observed, is suited to peculiar cases of injury or disease of the foot; and has its appropriate value. Whichever one is followed, it will be well to leave the flexor and tibialis anticus tendons, of sufficient length to enable them to contract adhesions with the end of the stump, and counteract the disposition of the gastrocnemius muscles to keep the heel in a state of permanent elevation, with the cicatrized surface presenting toward the ground. Bandages drawn from behind the heel and over the sole to the front of the leg, will have some tendency to prevent the production of this serious deformity, which impairs to a great extent the use of the heel as a point of support. In one case of the kind that came under my notice, the pressure from walking had produced ulceration of the cicatrix, followed by extensive caries of the bones, and I was compelled to resort to amputation of the leg. If the means already noticed do not suffice to prevent this deformity, the surgeon should not hesitate during the cicatrization of the stump, to take off the action of the gastrocnemius muscles by dividing the tendo-achillis, as in the operation for club foot.

AMPUTATION AT THE ANKLE JOINT.

Though mentioned by some of the older surgeons and advocated by some few of the modern, this operation is seldom practised at the present day; amputation of the leg being in almost all cases preferred to it. Instances in which the operation at this joint will be justifiable, may, however, occur among individuals whose circumstances in life place them above the necessity of physical exertion, to whom the preservation of a limb without obvious deformity and moderately useful, would be preferable to the more serviceable artificial leg. Serious objections to this ope-

ration are found in the extensive surface of the joint, and the scantiness of its covering, which together render it difficult to form a stump that will not ulcerate from the pressure to which it is necessarily exposed in walking, even with the best arranged and best padded boot. Lisfranc and Baudens, however, mention instances in which individuals who had undergone this operation were able to walk with ease ten or twelve miles a day. The process best suited to this amputation is the following, which it is said has been several times successfully performed by its author.

Process of Baudens. (Pl. XLII. fig. 5.)—The leg is to be sustained by an assistant, and the foot allowed to hang loose. The surgeon starts an incision below but on a line with the external malleolus, and runs it first along the outer border of the foot, then across the middle of the dorsal surface of the metatarsus, (so as to be here convex in front,) and then back along the inner margin of the foot, and round the heel to the point of commencement. The large oval flap of integuments thus traced out is to be rapidly dissected from the bones, and reflected circularly upon the leg. The surrounding parts are now to be cut so as to expose the circumference of the joint. The anterior and posterior portions of the capsule of the joint are next to be divided, and a rout for the saw traced with the knife across the two malleoli on the same level. The foot is then to be drawn a little downwards so as to admit the saw under the anterior edge of the tibia, and enable the surgeon to divide at the same time the two malleoli and the prominent posterior border of the tibia, and detach the foot. The anterior and posterior tibial arteries are to be tied, and the sides of the flap brought together over the ends of the bones so as to unite by first intention. A tight fitting boot is subsequently to be worn, and the absence of the heel supplied by a piece of cork and a soft elastic pad, upon which the stump is to rest.

2. OF THE LEG.

AMPUTATION IN THE CONTINUITY OF THE LEG.

Surgical anatomy.—The leg is formed of two bones connected together laterally at their upper and lower extremities, but separated in the rest of their extent by an interval which gradually decreases in breadth from above downwards. The bones are not upon the same level, the outer and smaller one—the fibula—being placed more posteriorly than the tibia. But inasmuch as the latter is much the larger of the two, the *posterior* surfaces of the two bones will be found nearly on the same level. Across the space between the bones is stretched the interosseous ligament, which serves both on its anterior and posterior faces for the origin of muscular fibres. The surfaces by which the bones look to each other are excavated in front and back to give space for the muscles, which, with several important vessels and nerves, are thus lodged between the bones, and can only be divided in amputation by a knife passed between and around the bones for that purpose. On its front and inner portions the tibia is merely covered with the integuments; on every other point, with the exception of the lower end of the fibula, the bones are covered with muscles. In their upper part they are most deeply covered; but as the limb tapers

from above downwards, the tendons will be found gradually substituted for the bellies of the muscles. In the calf, where the limb is thickest, the centre will be found behind the tibia, and the great or transverse diameter passing along the posterior face of the tibia goes through the centre of the fibula.

In amputation of the leg for diseases of the foot or ankle, the surgeon frequently has a choice of the point at which the bones may be divided. The general rule previously mentioned, of preserving in amputation the greatest possible length of the limb, is not so applicable to the leg as to either of the portions of the upper extremity. It is true, that the smaller the part lopped away, the less will be the shock upon the system; but as amputation of the leg, in any part of its course, is not under favourable circumstances attended with any great danger, the question is solely to be settled in reference to the use, for the future, of an artificial limb. There can be no doubt, that if the limb be cut off high up, preserving the flexor tendons of the ham, in order that, when bent, the end of the stump shall not make a very obvious projection behind the thigh, so as to proclaim the deformity and expose itself to injury, a simple and cheap substitute may be fitted to the knee under the most favourable circumstances possible for restoring the uses of the member in station and locomotion—the point of motion being, however, only at the hip joint. For these reasons the place for dividing the bone chosen by the great majority of practitioners, or the *place of election*, as it is called, is, for an adult, four fingers' breadth below the tuberosity of the tibia.

But many individuals so circumstanced in fortune, or following such sedentary pursuits as render unnecessary a constant or prolonged use of the limb in locomotion, are willing to sacrifice in part the stability of the apparatus, and the ease and facility with which it may be worn—preferring one, which, though less substantial, shall completely hide the deformity and restore the natural movements of the limb. To obtain this object, the motions of the knee joint must be preserved, and the stump left of sufficient length to be enclosed in a hollow boot and serve as a lever by which this may be swung like the natural limb by the flexor and extensor muscles of the thigh, the insertions of which upon the leg remain uninjured. The movements of the ankle joint are readily imitated by machinery, and to work well must occupy the interior of the substitute, a little space above the natural position of the ankle joint. The support of the limb must be got in a great measure from the ischium, and not from the cicatrized surface of the stump, which would be liable to ulcerate under pressure. To leave the stump of the appropriate length for this purpose, the bones should, therefore, be sawed about the middle of the leg, at what I would propose to call the *second place of election*. I amputated a few years ago in this manner the leg of a Swiss gentleman, for whom an apparatus such as I have described was prepared by M. Martin, of Paris, which enabled him, as I have since been informed, to walk and dance with ease and facility, and without exciting in lookers-on any suspicion of the extent of his misfortune. The apparatus is necessarily expensive and beyond the reach of many; complicated, and therefore liable to accident, rendering it convenient or necessary that a duplicate should be kept at hand. A clumsy and ill-fitting contrivance would only serve as a constant source of vexation

and pain to the patient, which is sometimes so great as to induce him to solicit a secondary amputation nearer the knee joint; and unless he can provide himself with a good apparatus of the kind, the operation at the common place of election, and the use of the usual more simple artificial leg, are decidedly to be preferred.

Several of the older surgeons, and some of those of the present day, have proposed, in order to preserve the greatest possible length of the limb, to amputate about three inches above the malleoli, where the bones are smallest and least resisting, and trust to means of support somewhat analogous to those provided in cases of amputation at the ankle joint. Various processes have been employed for this purpose, of which the common circular is usually considered the best—and there is no difficulty in effecting the cicatrization of the stump. But the measure has received but little favour, and is not likely to obtain much, unless it should be found possible to improve much beyond its present state the means of supplying artificial support.

In cases of injury or disease of the leg, extending so high up as to involve the first place of election, and yet allowing room for the covering of the stump by sawing through the spongy head of the tibia, the operation may be performed at this point, (which might be called the *place of necessity*,) in preference to amputating at the thigh or knee joint. By this practice, which was introduced by Barron Larrey, and has been approved by most operating surgeons, a tolerably good stump will be formed. In many cases it may be necessary, from the height at which the section is necessarily made, to disarticulate the head of the fibula. In my own practice I have generally managed to divide the head of this bone and leave it in its place, for fear that its articulation might communicate with that of the knee joint,—a circumstance which is said to occur in about one case in ten, and which, if found to exist, might give rise to extensive synovial inflammation.

AMPUTATION AT THE FIRST PLACE OF ELECTION.

Circular method modified. (Pl. XLIII. fig. 1.)

1. The *instruments* usually required consist of the tourniquet, a straight-edged amputating knife at least seven inches long in the blade, an interosseous knife or catling, two or three scalpels, a saw, a pair of cutting pliers, forceps, tenaculum, a few threaded needles, and a three-tailed retractor. Some surgeons prefer for every step of the operation a strong double-edged knife or catling; others have the back of the amputating knife ground for a little distance from the point, so as to avoid the necessity of changing it for the small catling in dividing the parts between the bones; and if an assistant be at hand who may be relied upon to make firm and steady pressure upon the artery of the thigh with his thumbs or fingers, the tourniquet may be dispensed with. If the latter instrument be used, it will be well, immediately before it is tightened, to elevate the limb for a few moments, in order to diminish the amount of blood accumulated in the veins, which would necessarily be wasted.

2. *Position of the patient and assistants.*—The patient should be placed semi-recumbent upon a bed, or a narrow table well garnished with blankets, the trunk supported with pillows, and the legs pendent over the end. An assistant draws with one

hand the healthy leg, flexed, to one side, and rests the other upon the shoulder of the patient. Another assistant sustains the foot of the opposite side, and watches attentively the movements of the surgeon, so as neither to splinter the bones nor pinch the saw. A third assistant supports the diseased limb above the place of operation, and draws back the soft parts. A fourth manages the tourniquet, or compresses the artery with his thumb over the pubis. And a fifth should be prepared to hand the instruments in the order in which they are wanted, and receive them again as the surgeon is prepared to lay them down.

3. *Position of the operator.*—This is a point in regard to which there is a great diversity of opinion;—some surgeons always placing themselves on the inner side of the limb, so that in dividing the bones the section of the fibula may be completed before that of the tibia, in order to guard the more surely against the splintering of the former. Others, believing the neat division of the soft parts a matter of greater importance, take a position always on the right side of the limb, so as to be able to grasp it with the left hand immediately above the place of operation. The latter I have found most convenient in practice, and a surgeon familiar with the use of the saw will have no difficulty even in operating on the right leg, of dropping the hand so as to divide the fibula before finishing the section of the larger bone of the limb. For the posture of the operator, the following minute directions have been given by Lisfranc:—The right thigh flexed at a right angle with the pelvis, the leg bent upon the thigh, and the foot resting flat upon the floor;—the left thigh flexed at an obtuse angle with the pelvis, the leg at an acute angle with the thigh, the tuberosity of the ischium supported upon the heel, and the point of the foot upon the ground, with the legs separated in order to give greater solidity and precision to his movements.

1st step.—The surgeon having previously determined how far it is necessary to go below the intended place of section of the bones to get a sufficient covering for the stump,—which must depend in a measure on the thickness of the limb,—marks with his left thumb on the crest of the tibia the point for commencing the incision. Then carrying the amputating knife below and around the limb, he lays the edge, with the wrist bent and the hand strongly pronated, upon the internal face of the tibia, (or if it be the right leg, and he stands at the outer side, as far as possible on the external face of the crest,) and pressing so as to cut through the skin and fascia, brings the knife round the leg at a steady and single sweep, carrying the heel up to the point at which the incision was begun. As the handle of the knife is brought upwards, it shifts its position in the palm, which gradually becomes more supine, and the circular incision is finished with the handle placed between the thumb and the first two fingers. A little practice will render this *tour de maitre* easy. It is not, however, absolutely indispensable that the incision should be made by a single cut, many surgeons contenting themselves with making two separate incisions from above downwards, which unite below. The surgeon now changes the amputating knife for a common scalpel or bistoury, dissects up rapidly the skin and superficial fascia for the space of an inch and a half from the aponeurosis of the leg, and turns them back in the form of a sleeve with the fat outwards.

2d step.—With the amputating knife carried round the limb and held in the same manner as for the incision of the integuments, a circular cut is made at the base of the reflected skin so as to divide all the soft parts down to the bone. As the knife is brought under the calf, where the greatest amount of muscular structure is found, it is necessary to give it two or three sawing movements to make it penetrate to the bone, after which the circular incision is to be completed. The muscles, vessels and nerves, lodged in the interosseous spaces, still remain to be cut; their division is to be accomplished by carrying the cutting or the double-edged amputating knife, if such has been used, between the bones, each of which is to be circumscribed separately. The same result may be accomplished with more rapidity in the following manner.

Pass the knife from above so as to divide vertically the interosseous membrane for the extent of an inch, (which is usually rendered easy in the living subject by the retraction of the divided muscles,) for the purpose of facilitating the entry of the knife and the action of the retractor. Then carry the knife below the limb, pass it transversely through the anterior interosseous space, and, using it like a bow, make the cutting edges act alternately upon the tibia and fibula, so as to divide as much as possible the included parts; then turning it round one of the bones, enter it again through the posterior interosseous space to complete the division of the remaining fibres; and lastly, carry it over the other bone to the point at which it started.

3d step.—The middle one of the three tails of the retractor is now to be passed with the dressing forceps from below upwards through the interosseous space; the two outer tails are to be crossed, and an assistant seizing the two ends of the retractor draws the soft parts well upwards. The surgeon, grasping the retracted flesh with his left hand, applies the heel of the saw, propped against the nail of the left thumb, upon the crest of the tibia, and begins the division of the bone by drawing the saw lightly to him; when the saw has fairly cut its groove on the tibia, he proceeds with a bolder stroke to complete the section, taking care to divide the fibula first. If the subject is thin, and the amputation is done low on the leg, the spine of the tibia, which will be found very prominent and liable to become denuded or cause ulceration of the integument, should be removed with the saw. This may readily be done after the transverse section of the bones, by passing the saw obliquely across the spine and anterior edge of the tibia. Beclard directed the first strokes of the saw obliquely upon the crest, a little above the place of the intended section, and then withdrew the saw to begin the transverse cut below.

Any spiculæ or rough edges of the bone are to be removed by the cutting pliers. As the muscles on the posterior part of the leg retract more than those on the anterior, various modifications have been suggested as to the manner of dividing them. Alanson cut them with a bevel inwards. Sir C. Bell directed the gastrocnemii to be cut obliquely from below upwards, and the others to be divided on a level with the top of this incision. B. Bell, with the object of keeping them as much as possible on the same level, and cutting the bones high, separated the fibres from round the tibia and fibula with the scalpel, so that they might be pulled up by the retractor. This last, with the direct

circular section of the muscles, is the plan more usually followed. It is a modification of considerable importance, when the limb is emaciated and the bones large.

Dressing.—The arteries to be tied are, 1, the anterior tibial, which will be found in front of the interosseous ligament, in close contact with its nerve, from which it is to be carefully isolated. Sometimes it is difficult to discover this vessel; the tourniquet must then be slacked after the other vessels are secured, to discover its position; 2, the posterior tibial; 3, the peroneal—both of which are found behind the interosseous ligament, and near the surfaces of the tibia and fibula; 4, the two gastrocnemial, and occasionally a fifth of considerable size, the nutritious artery of the tibia. If this last is cut in its sheath of periosteum, it must be dissected up before it can be tied; if in its passage through the bone, the orifice must be plugged with a piece of wax. The arterial distribution will be found, however, to vary, according to the height at which the limb is amputated. If the operation be performed as high as the tuberosity of the tibia, the popliteal, which is cut before its division, the gastrocnemial and some articular branches, are all that require the ligature. In one instance in which I operated for dry gangrene, the main trunks were found so plugged with coagula, that none but the gastrocnemial branches required to be tied.

The arterial hemorrhage having been completely arrested and the tourniquet slacked, the surface of the wound is to be well cleared of the coagulated blood, and the lips brought together with the palms of the two hands in the direction in which they will best cover the bones and supply the deficiency of the soft parts in front. Reunion obliquely from above downwards and within outwards, will be found best to subserve this purpose, as it allows the skin to fall easily on the anterior part of the tibia, and facilitates the discharge of pus at the lower end of the wound—an object which will be further promoted by the introduction of a small linen compress between the edges at this point. The flaps are now to be secured with adhesive straps, and the dressing terminated as described at page 137.*

Notwithstanding the general favour in which the circular method of amputating the leg as just described is held, there are some objections of moment that have been urged against it. The leg being necessarily placed in extension, the skin is drawn up towards the knee, and cut so short, that it will be found when the stump is dressed and bent at the knee, drawn more or less tightly over the spine of the tibia, so as to be exposed to ulceration. From the same position of the limb, the muscles and skin on the back part of the leg will be relaxed, and found divided relatively too low, so as to form after the dressing an unseemly puckering of the integument, and a useless mass of muscle, which is liable to become engorged with blood, increase the amount of suppuration at the back part of the wound, and prolong the process of cicatrization.

In my own practice these disadvantages have been obviated by the following simple modification, which forms a part of the oval process of Baudens; viz., to divide the skin obliquely, or in an oval, so as to make the first incision a full finger's breadth lower on the front than on the back part of the limb; dissect the integu-

ments up for two inches, and divide the muscles by a circular cut;—the remainder of the process being the same precisely as that already described.

Flap method. (Pl. XLIII. fig. 6.)

This has been practised either by the single flap, after the manner of Lowdham or Verduin, or with two flaps, as was the custom with Vermale and Ravaton. The process by single flap is the only one now employed, and is received in this country, England, and Germany, with at least an equal degree of favour with the circular method. The flap may in cases of necessity, be formed chiefly from one or both of the sides of the limb; but where the surgeon has a choice, it is to be taken from the posterior portion. It may be cut from below upwards, and from the skin towards the bone, as practised by Sir C. Bell, Græfe, and Langenbeck; or, as is now more commonly preferred, by previous transfixion, and incision from within outwards and downwards. Of the processes employed, those of Liston (which is but a modification of that of Verduin,) and Sedillot appear entitled to the greatest favour. The former I have repeatedly had occasion to practise, and have found it to answer admirably well. The only instruments required in this mode of operation, will be a narrow double-edged knife seven inches long and the saw. The patient, surgeon and assistant, are to be placed in the manner described for the circular method.

Process of Liston.—"An assistant supports the affected foot, another puts the integument above on the stretch, and is ready to hold back the parts during the incisions, and after they have been completed. When the right limb is the subject of operation, the point of the knife, having been entered on the outside, behind the fibula, is drawn upwards along the posterior border of that bone, with a gentle sawing motion, for about a couple of inches; the direction of the incision is then changed, the knife being drawn across the fore part of the limb, in a slightly curved direction, the convexity pointing towards the foot; this incision terminates on the inner side of the limb, and from this point the knife is pushed behind the bones, and made to emerge near the top of the first incision; the flap is then completed. All this is done smoothly and continuously, without once raising the knife from the limb. The interosseous, muscular, and ligamentous substances are cut; the anterior flap is drawn back, and its cellular connections slightly divided; both are held out of the way by the assistant, and the separation completed with the saw. By proceeding thus, all risk is avoided of entangling the knife with the bones, or betwixt them. In dealing with the left limb, the proceeding is very similar; the internal incision is not made quite so long; but it should still be practised, for a longitudinal opening of about an inch or more in extent is more easily found in the transfixion, than the mere point at which the interior incision is commenced. In sawing the bones of the left leg, the tibia may safely be cut first, as the surgeon commands the limb during the process, and can easily obviate the risk of snapping the fibula. The awkwardness attendant upon a change of position is thus avoided. Disarticulation of the fibula is not advisable, owing to the connection of its head with the bursæ and knee joint. It is seldom necessary to round off the spine of the tibia.

"Amputation close to the joint is performed precisely in the

* The surgeon should not forget previous to the operation to have the integuments shaved.

same manner; the incisions being made so that the fibula is exposed and sawn immediately below its head, the tibia close to the tuberosity. One great advantage attending this amputation is the shortness of the stump; the patient, resting on the knee, can cover both his wooden support and stump with his trowsers. Another immediate advantage is the facility and rapidity with which the whole proceeding can be executed. In very many cases I have managed so as to tie one vessel only—the popliteal—and this materially shortens perhaps the most painful part of the whole process.”*

Process of Sedillot.—Enter the point of the knife about three-quarters of an inch to the outer side of the crest of the tibia, and carry it downwards till it strikes the fibula; slide it round the outer face of this bone, bring it out at the posterior aspect of the leg, and cut from above downwards a flap three to four inches long. This is to be immediately raised by an assistant. Detach the muscles thus put naked for half an inch above the base of the flap, from the tibia, fibula, and interosseous ligament. Unite the two angles of the incision by a circular division of the remaining parts, and dissect them up as far as the muscles have been detached. Turn back this cutaneous and fleshy mass in the form of a cuff; cut sloping inwards, in the manner of Alanson, the muscles on the internal and posterior face of the leg; divide the interosseous muscles; apply the retractor, and saw the bones. After the arteries are tied, the flap is to be brought down over the entire surface of the tibia, and attached to the integuments of the inner side with the twisted suture. The cicatrix will occupy one-half of the circumference of the stump; viz., that of the internal and posterior side.

The above is the description of this operation as given by M. Bourguery, who witnessed its performance, and makes in regard to it the following observations. “We do not fear to present this process as one of the most rational that can be contrived for amputation of the leg at the place of election: the end of the tibia is completely covered by a muscular flap, and cannot escape through the anterior angle of the wound; the skin is not exposed to gangrene, the cicatrix is linear, and the union of the surfaces ought readily to take place. The covering of the stump presents a good cushion, if we wish to employ the artificial leg of Verduin;† and, in a word, this process unites all the advantages of the circular and flap methods.”

The *oval method*, with the exception of its application for the division of the integuments as the first step to the circular operation, has not been to much extent employed in the amputation of the leg.

Amputation at the second place of election—in the middle of the leg—or at a point *three inches above the malleoli*, which some have chosen, may, (provided the latter should from any circumstances be deemed justifiable,) be practised by the circular and flap methods, according to the processes above given. But if the muscles be but little developed, or thinned considerably by emaciation,

* Practical Surgery, p. 378-80. American edition, 1843.

† The substitute of Verduin was intended to support the limb, by receiving the surface of the stump against a well-arranged pad, and is to a considerable extent analogous to the apparatus recommended by Professor Fergusson. The objections that may be urged against this mode of support have been stated in another place—p. 165.

the paucity of materials for the flap renders the circular most eligible.

AMPUTATION AT THE PLACE OF NECESSITY, OR THROUGH THE CONDYLES OF THE TIBIA.

This is but seldom called for or even practicable, except in cases of traumatic injury. I have, however, witnessed its successful execution in the hands of my friends, Prof. Horner and Dr. E. Peace, of this city, and in one instance had occasion to perform it myself with a like result. The spot, however, is not favourable to the operation, in consequence of the necessity of avoiding the division of the ligamentum patellæ, the scantiness of the muscular tissue about the bone, and the large size and vascular structure of the latter, which render the cure tedious and expose the patient to the risk of phlebitis and purulent absorption. It offers, nevertheless, the advantage of preserving the knee joint, and is attended by less risk than the amputation of the thigh or the disarticulation of the knee.

Modes of operation.—The choice of the process must be determined at times by the nature of the lesion. If the soft parts in front are involved, the ends of the bones must be covered by a flap taken from the posterior part of the leg. If the bones are shattered on their back portion, the saw entered near the tuberosity of the tibia may be made to act obliquely upward and backward. We may divide the bone even through the insertion of the ligament of the patella, leaving enough remaining to preserve its attachment and protect the bursa behind it. In general, the circular method, which was the one employed by Larry, will be found the most appropriate for this operation. It is to be practised according to the usual process, with no other modifications than those rendered necessary by the peculiar structure of the parts. In dissecting the fold of skin, which is to be made as large as possible, the operator should guard against doing violence to the cellular tissue of the ham, as this part might otherwise become the seat of abscess. The section of the muscles will be found more difficult than in the ordinary amputation of the leg, in consequence of the narrowness of the interosseous space and the size of the tibia, which render the manœuvre with the catling difficult. Whenever it is allowable, the head of the fibula should be sawed rather than disarticulated; but if it is necessary in consequence of its condition to disjoint it, the surrounding muscles must be dissected off, and the knife carried through the articulation in a curved direction from within outwards and from below upwards.

AMPUTATION AT THE KNEE JOINT.

The propriety of the performance of this operation under any circumstances, is one of the controverted points of surgery. It has been alleged, that even after a cure the patient would be unable to make a point of support of the stump, by applying it upon the padded end of the ordinary wooden leg; but the observations of Velpeau and Baudens, and my own experience in a single case, prove at least its possibility. That instances may occur affording a choice, only, between amputation at the knee joint or the thigh, in which from the exhausted state of the patient,

the chance of recovery will be greater by the comparatively small division of parts at the joint, I have little reason to doubt, especially when we consider the ratio of mortality which attends the amputation of the thigh. But as my own experience is exceedingly limited, and not more than two or three amputations at most at the knee joint have been performed in this country, I cannot do better than quote the following statements of Dr. King, and let the practitioner make his own estimate of the arguments.

"The question of *amputation at the knee joint* has been long regarded by the generality of surgeons as finally settled. Numerous successful cases, however, in which this operation has been resorted to of late years, either from necessity or the individual views of the surgeon, have again brought it under consideration. Some very eminent practitioners have thought that the amputation of the leg at the knee joint has been too indiscriminately proscribed, while others, going still further, blame the timidity that has prevented surgeons from boldly penetrating into large articulations, and assert its superiority over amputation as performed in the continuity of the bones, either of the leg or thigh. The arguments against amputating in joints, especially of large size, have been laid down, and though we still adhere to our objections to these amputations, unless as exceptional proceedings, where an unusual prospect of success, or an unusual necessity might justify us in deviating from what we deem a safer course, still we see no reason against briefly stating the arguments of those who consider that this operation has been too lightly condemned.

"They affirm, that so long as the periosteum of a bone, or the articular cartilage covering a bone, is uninjured, no bad consequence can arise from exposure to the air, as these coverings afford a perfect protection against inflammation; that there is no synovial membrane spread over the cartilages; that it is almost always possible to save a sufficient quantity of the surrounding integuments to form a good and ample covering for the exposed condyles; that the wound is not so large as some imagine, the flap being formed almost exclusively of integument, which adheres most readily to the condyloid surfaces; and finally, that the disarticulation of the leg leaves not only a good stump, but that it preserves the mobility of the head of the thigh bone in the acetabulum, which is lost when the amputation is performed in the continuity of the femur. When the amputation is performed at the knee joint, the individual walks with an artificial leg, as if he had a stiff knee. But when the thigh is amputated, progression is by no means so free—he walks as if the head of the thigh bone was ankylosed."*

Surgical anatomy.—Notwithstanding its complex structure, the articulation of the knee presents few obstacles to the performance of the operation. The condyles of the femur and tibia are readily felt from the exterior, and indicate the position of the joint, which is found behind the patella, and four lines above the head of the fibula. Strong lateral ligaments, tendons, and aponeurotic expansions are found on the sides of the articulation; on its posterior surface are the ligament of Winslow, the popliteal vessels and nerves, and the heads of the popliteus and gastrocnemius muscles. The latter muscle is the only one fleshy at this point; it cannot, however, be made available as a covering for the stump, as it receives its supply of blood from arteries that arise below the

joint, which must necessarily be cut off by the division of the main trunk on a line with the condyles, rendered almost unavoidable in consequence of the close contact of the popliteal artery with the posterior part of the joint. At the interior of the joint, the attachments of the crucial ligaments to the condyles, which are readily presented to the knife, are the only fibrous parts of importance to be divided. The question of removing or leaving the patella has been much debated. It is now decided, however, that it ought to be preserved, and for this purpose the incision into the front part of the joint must be made through the ligament below that bone. The three methods have been employed for this disarticulation. That of the flap was employed by Hoin so early as 1764. The circular and the oval have been but recently practised.

Flap method.—By the processes of Hoin and Blandin, the flap is formed out of the muscles and skin on the posterior part of the leg, and the joint opened by a division of all the parts from the surface of the skin below the patella to the posterior part of the condyles. Leveillé, Smith, and Beclard, raised in addition a semi-circular flap of skin from the surface below the joint. Rossi formed two lateral flaps, by making first two vertical incisions—one in front and one behind the leg, uniting them by a circular incision, dissecting up the integuments, and subsequently dividing the parts on a line with the joint. Neither of these processes can be considered favourable; for such is the retraction of the skin upwards by the strong muscles, whose tendons have been cut, that a part of the articular surface is ultimately left naked. The muscular flap at the posterior part is difficult to be kept applied, and requires to be punctured largely in its middle, to allow the sero-purulent secretion from the condyles to escape. The following process will be found to give a very efficient covering for the stump, and supply a ready outlet to the matter.

Process employed by the author.—In the winter of 1841 I removed the leg of Rachel Morris at the knee joint before the class of the Jefferson Medical College at the Philadelphia Hospital. The patient was about thirty-five years of age, and had suffered for several years with necrosis of the entire shaft of the tibia. The profuseness of the purulent discharges, in conjunction with repeated attacks of diarrhoea, had so broken down her strength, that it had been difficult to prevent her sinking. As the bone was found involved up to the condyles of the tibia, and the integuments were impaired so high up as to render it impossible to perform even amputation through the condyles after the manner of Larrey, there was no alternative save the removal of the limb through the thigh or at the knee joint. As the chances of recovery after amputation of the thigh, considering her exhausted state, were deemed but small, I decided to remove the limb at the knee joint, especially as the structures of this articulation were unaffected by disease. The operation, in which I was assisted by Drs. Mütter, Coates, and others, was done in about two minutes with the scalpel merely, according to the following process, though from the extension of the disease on the front of the leg, I was unable to cut the anterior flap of the length described as most appropriate.

The cure, which was not rapid, as the cicatrization was not completed till the end of four weeks, was unattended by a single bad symptom, the patient gradually increasing in health and

* Cyclopaedia of Surgery, art. Amputation, by T. C. King, M. D.

strength from the first day of the operation. From the unavoidable shortness of the flap covering the condyles, one of these processes became partially exposed, so as to allow me to observe the changes which the articular cartilage underwent. This structure neither reddened nor became painful, so as to exhibit any coating of synovial membrane, or other appearance of organization. It became by the end of a week softened and pulpy on its

free surface, in the same manner as when a recent joint is subjected to the macerating tub of the anatomist. The pulpy layer, which was so soft as to leave a track when rubbed with the end of a probe, was insensibly removed with the discharges; by a continuation of the same process of softening and removal, the thin lamina of bone covering the articular face of the condyles was completely bared of the cartilage in the third week. This

PLATE XLIII.—AMPUTATIONS OF THE LEG AND THIGH.

(Fig. 1.) CIRCULAR AMPUTATION OF THE LEG OF THE RIGHT SIDE. (*Modified by an oval incision of the skin. First place of election.*)

The first two steps of the operation have been accomplished—1, the oval incision (*d*) of the integuments, (as in the process of Scdillot; the skin has been subsequently dissected loose from the fascia and turned back;) 2, the circular section of the muscles at the base of the fold of skin, and the division of the interosseous muscles and ligament with the catling; the retractor is also shown applied.

The drawing represents the period of the operation when the surgeon is about to apply the saw for dividing the bones.

- a.* The hand of an assistant sustaining the leg at its lower end.
- b, c.* Left hand of the surgeon grasping the upper end of the leg, so as to steady it for the saw. The hand is applied over the three-tailed retractor, with which another assistant draws up the divided soft parts; one of the tails has been passed between the bones.

(Figs. 2, 3, 4.) AMPUTATION AT THE KNEE JOINT. (*Process of the author.*)

Fig. 2.—Anterior incision.

The patient has been laid on the abdomen, and the leg raised so as to flex it on the thigh. A semilunar incision convex downwards has then been made across the front half of the leg, three fingers' breadth below the tubercle of the tibia, so as to mark out an anterior flap of skin.

Fig. 3.—Posterior incision.

The position of the patient remaining unchanged, the leg is brought down so as to be placed in a state of extension. The scalpel has then been entered on the back part of the leg, just below the popliteal fossa, so as to make a vertical incision in the middle line; from the lower end of this a semilunar incision convex downwards, has been directed on either side to the rounded track of the first or anterior incision. Two posterior lateral flaps are thus formed, one of which is seen dissected up from the fascia of the leg, and partially reverted.

Fig. 4.—This drawing represents the mode of closing the flaps over the condyles of the thigh. The three flaps are attached together at their place of junction by sutures. A small greased compress is placed between the lips of the posterior flaps on the popliteal surface of the stump, to give vent to the sero-purulent discharge which attends the softening and exfoliation of the cartilage on the face of the condyles. The rounded upper portion of the figure is the end of the femur and patella covered by the anterior flap.

The stump of the patient upon which this operation was performed, still presents very much the same appearance as seen in the drawing. The whole line of the cicatrix is over the notch at the posterior surface of the condyles, behind the point of pressure upon the wooden leg, and the patella is now immovable upon the femur.

(Fig. 5.) DOUBLE FLAP AMPUTATION IN THE MIDDLE OF THE LEFT THIGH. (*Process of Liston.*)

The circulation in the femoral artery is to be arrested by pressure by an assistant, or with the tourniquet. The soft parts have been grasped in the left hand of the surgeon, and drawn as much as possible in front of the bone, and the knife passed from the outer side—first down upon the bone; then the handle has been inclined downwards, to allow the point to slide over the anterior surface, and again raised to let the point descend on the inner side of the bone and pierce the skin as far back as possible on the inner side to give breadth to the anterior flap. The knife has then been carried down with a sawing motion to form the anterior flap. In the period of the operation shown in the drawing, the flap has been raised by the hand of an assistant (*a*), exposing the front half of the bone (*b*), and the knife has been again passed across between the two angles

Fig. 1.

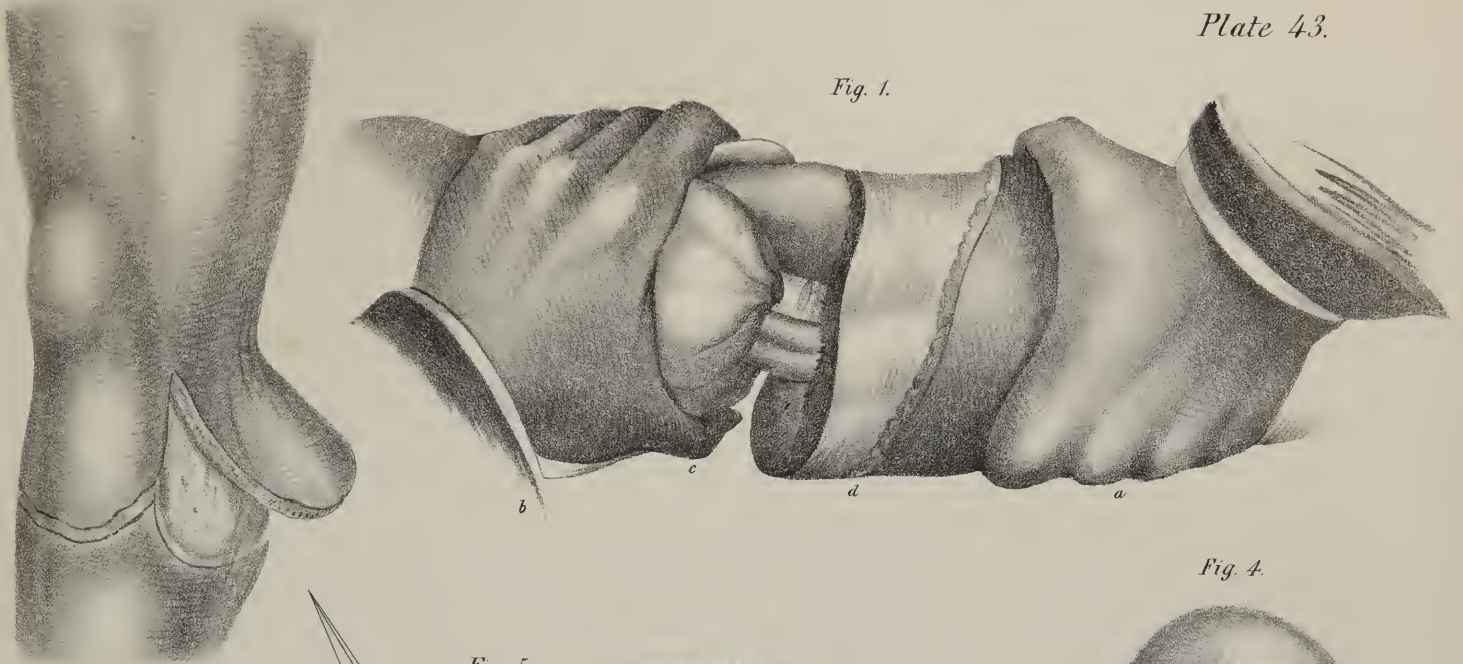


Fig. 4.



Fig. 5.

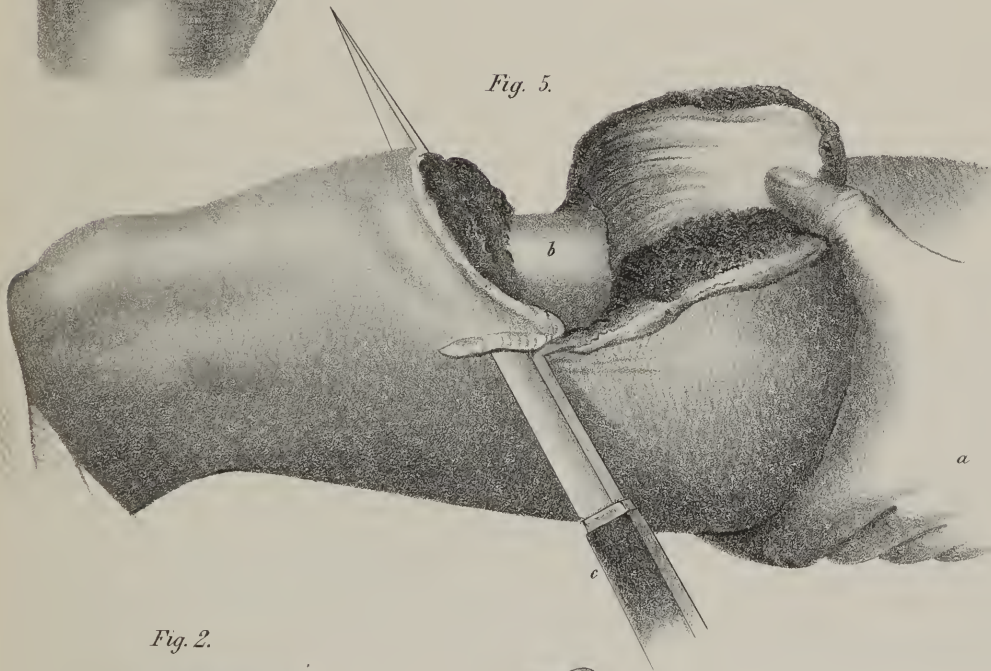
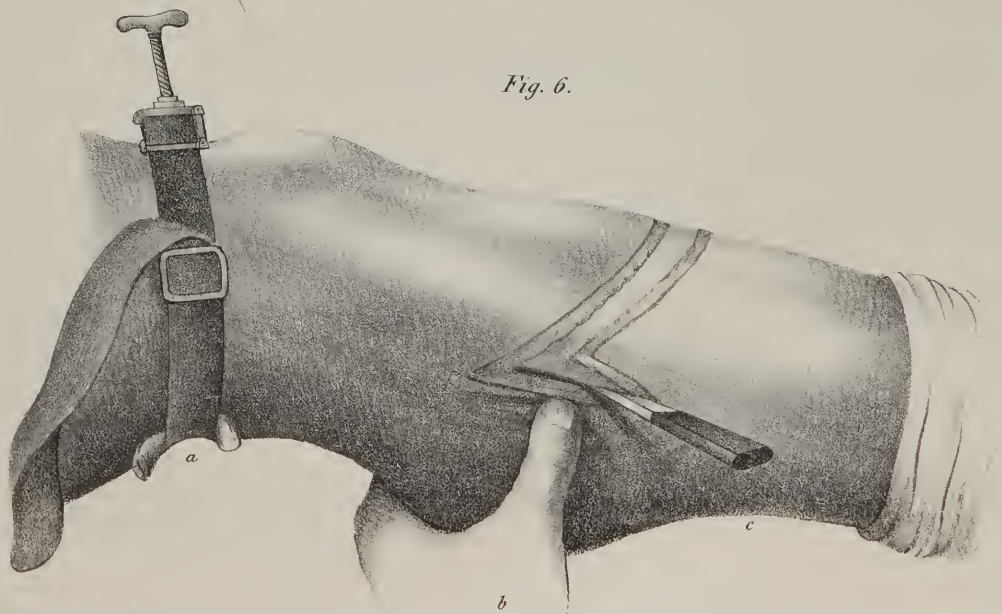


Fig. 2.



Fig. 6.



lamina first presented a dark gray aspect; some small gray conical elevations soon after made their appearance on its surface, and shortly grew into florid, healthy granulations, to which and to other granulations that sprang from the severed ends of the crucial ligaments the cutaneous flaps were ultimately firmly united. No appearance of synovial inflammation of the bursa above the joint was manifested during the treatment, and the patella remained movable on the upper anterior surface of the condyles. The line of cicatrization was drawn backwards by the hamstring tendons, so as to be opposite the notch between the condyles, and the patient now preserves a useful limb, with which she moves about with great ease and facility, by applying the healthy surface of the skin covering the condyles upon a hair cushion at the top of the ordinary wooden leg.

Process of the author. Three cutaneous flaps. (Pl. XLIII. figs. 2, 3, 4.)—The patient is to be placed upon the abdomen. The leg, flexed at a right angle with the thigh, is held by an assistant. The surgeon, placing the thumb and fore finger upon the condyles of the tibia at the opposite sides of the leg, makes with a common scalpel on the front of the upper part of the leg, a semilunar incision which extends as far as three inches below the tubercle of the tibia—one extremity resting on either side an inch below the joint. The flap of skin is now to be rapidly dissected towards the joint. The leg is then to be extended and made horizontal. The point of the knife is next to be entered through the skin at the middle of the back part of the leg, an inch and a half to two inches below the fossa of the popliteal space, and carried vertically downward to the extent of three inches. From the lower end of this, the knife is to be continued round on one side to strike the line of the first or anterior incision, so as to mark out a second flap, convex downwards, and extending a little lower than that of the one in front. The lower end of the vertical cut is then united by a similar convex sweep of the knife to the other margin of the front incision, so as to form a third flap. The two posterior flaps are next to be dissected from the fascia up to their base. The leg is now to be again flexed, and from the general loosening of the flaps already made, the insertion of the ligamentum patellæ upon the tibia will be exposed. This is to be divided across and the joint opened upon the front and sides so as to leave the semilunar cartilage on the head of the

tibia; the crucial ligaments, as they become subsequently useful as a nidus for granulations, are to be divided at their connection with the latter bone, and the posterior ligament lastly cut. The leg, which is now loose, is to be twisted on the thigh. An assistant grasps the popliteal artery with the thumb and finger, and the surgeon divides below at one stroke with the knife the remaining parts, consisting mainly of the two heads of the gastrocnemius, some of the hamstring tendons not previously cut, and the popliteal vessels and nerves. The patella is to be left in its position.

The whole operation may be done with the scalpel; the femoral artery should be compressed with the tourniquet.

Dressing.—The anterior flap is to be brought over so as to cover the condyles, and united by suture to the two lateral flaps, which will be found so considerably retracted as to fit in neatly to each other along the notch between the condyles. A few strips of adhesive plaster are to be applied, and a roller brought down from the upper part of the thigh, in order to overcome the tendency of the loosened muscles to retraction, and fix the patella near to the end of the bone.

Circular method. Process of MM. Velpeau and Cornuau.—The leg is to be extended on the thigh, and the skin divided circularly three or four fingers' breadth below the patella, without interesting the muscles. It is then to be dissected loose, preserving all the adipose tissue on its under face, and drawn upwards by an assistant to the level of the joint. The ligament of the patella and the lateral ligaments are next divided in succession. The leg is now to be flexed so as to separate the osseous surfaces, and the semilunar cartilages detached so as to be left on the tibia. The operator then cuts the crucial ligaments, traverses the joint, and finishes the operation by dividing at a single stroke of the knife, the vessels, nerves and muscles of the ham, on a line with the base of the reflected skin.

Oval method. Process of Baudens.—The leg is to be extended on the thigh. The surgeon starts, five inches below the patella, a semicircular incision of the integuments, which is to be carried obliquely upwards upon one of the sides of the leg, and turned round the ham one finger's breadth below the top of the tibia; the incision is then to be brought downwards in the same manner on the other side of the leg, so as to terminate at the place of com-

of the wound, *but behind the bone*, for the purpose of forming the posterior flap, which should be an inch longer than the anterior.

(Fig. 6.) FLAP AMPUTATION OF THE LEFT LEG.

Process of Liston, slightly modified by giving a greater length to the covering in front of the tibia, so as to obviate any liability to the projection of the crest of this bone during the cure.

The knife has been entered on the outside of the leg, so as to make a short vertical cut on the posterior face of the fibula, and then brought round over the tibia in a semi-elliptical sweep and passed through the leg, shaving the posterior face of both bones, as seen in the drawing. The common tourniquet is applied just above the knee, with a compress in the ham, so as to command the popliteal artery. The surgeon grasps the calf of the leg with his left hand in order to draw back the soft parts, while he employs the knife with his right to make the incisions and puncture above described, and cut out so as to form the posterior flap. In making the transfexion on the left leg, the handle of the knife should be kept more elevated than the point, to prevent the latter getting entangled between the bones. If he operate on the right leg, and stand on the outer side, the handle may be depressed a little, so that the point of the knife may shave the posterior surface of the bones.

mencement. The oval section of the skin in front is now to be dissected and turned up so as to expose the circumference of the joint. The ligaments, muscles and vessels are next to be divided by a circular incision on a level with the joint. The articulation is then to be opened, and the semilunar cartilages and crucial ligaments detached as in the circular process.

By this process, which may be rapidly executed, the surface of the condyles can be covered by a large cap of integument, which leaves the line of union behind so as to form a ready outlet for the discharges, and be posterior to the point of pressure after the cure.

Relative value of these methods. As the chief accident to dread after the operation is the exposure of one or both of the condyles, the oval, which leaves the larger fold of skin in front, has some advantages over the circular method. But in most cases admitting of its employment, we might, except there be some injury or disease of the bone extending high up, advantageously substitute for it the flap operation of Liston for the leg, sawing through the tubercle of the tibia. The operation by three flaps, such as has been described on the preceding page, will, I believe, be found to form a still neater and better fitting covering to the uneven surface of the bone than the oval, and is moreover applicable to cases where the disease of the integuments of the leg has extended so near to the joint as to prevent the employment of the latter.

Dressing.—The popliteal is the only large artery to be tied. The gastrocnemial and some small branches from the articular arteries, will also require the ligature. The parts are to be brought together with adhesive straps, so as to leave the cicatrix as much as possible behind and between the condyles, and a roller brought from above downwards on the thigh, in order to overcome the tendency of the muscles to retract. In case the covering should be found insufficient for the end of the bone, the condyles might, I believe, be amputated with great propriety, thus reducing the operation to that of the ordinary amputation of the thigh, but preserving nearly the whole length and the action of most of the muscles of the limb.

3. OF THE THIGH.

AMPUTATION IN THE CONTINUITY OF THE THIGH.

Surgical anatomy.—The structure of the thigh is in many respects analogous to that of the arm. It consists of a single bone, surrounded on all sides by a mass of muscles, which are more or less capable of shortening themselves after division in amputation, according to the degree in which they are connected with the shaft of the bone. On the inner and posterior surface, the bulk of muscles will, however, be found the greatest. There are three classes of muscles: those which connect the limb with the trunk—those that stretch loosely along it, connected below only with the bones of the leg, and above with those of the pelvis—and those which, having their origin from the pelvis, cover and are connected only with the surface of the thigh bone. They are all, however, for practical purposes, arranged into two groups—a superficial and a deep-seated.—The superficial are those which have little connection with the femur, and are stretched mainly between

the pelvis and the leg. In consequence of this and of their greater length, they will retract more after amputation than the deep-seated, which are connected with the bone; the extent of the retraction will also be the greater the longer the muscles are left, or the nearer the operation is done to the knee joint. In the circular amputation, if all the muscles were divided on a circular line, this inequality in the degree of retraction of the two sets would render the bone prominent, producing the painful and annoying result of a conical stump. This difficulty is obviated by the following plan: viz., to cut first, by a circular sweep, all the layers of the superficial group, and divide the deep-seated by a second incision at a point a little higher than that to which the former have retracted, sawing the bone at a little distance still further up. If the first incision should be carried down to the bone, we insure more completely the division of the outer set, and the disadvantage of making a second cut of the deep-seated is of but little moment compared to the general result.

In the flap operation the same arrangement of parts must be held in view, and the flaps cut of a length apparently unnecessarily great, in order to admit of the subsequent shortening from muscular contraction. At the end of the cure the cicatrix is nearly always carried inwards and backwards, and the bone pressed towards the upper surface. This may be remedied by dividing the muscles lowest on the posterior and inner face of the limb; especially the semitendinosus and semimembranosus, as these are found susceptible of the greatest degree of shortening. The skin is loosely united to the fascia of the thigh, everywhere, except at the popliteal region. It is sometimes in obese individuals doubled with so thick a layer of adipose tissue, that the surgeon in turning the fold of skin in the circular operation will find the cure of the wound facilitated by leaving a portion of the fat adherent to the deep fascia. The extent of the fold of skin required for the circular process must be calculated according to the diameter of the limb, without reference to the shortening of the muscles, for the base of the fold will be found to ascend nearly in proportion to the retraction of the latter. In general, it should be about equal to its distance from the bone, whether we operate at the upper or lower part of the leg;—at the upper in consequence of the thickness of the muscles, and at the lower on account of their retraction.

There is no *place of election*, admitted by common consent, for amputation of the thigh. The general rule is to preserve as much of the limb as possible, and the danger to life is certainly proportioned to the height at which the operation is performed. Mr. Liston has, however, recommended that the division of the bone, for the greater convenience of fitting the stump to the artificial leg, should not be made below the middle of the thigh.

Circular method.—The patient should be placed nearly horizontally upon the table, with the pelvis resting over its edge, and the same instrumental and other preparations made as in amputation of the leg. In order to diminish the degree of the subsequent shortening of the muscles, the leg may be slightly bent on the thigh, and the latter on the pelvis. The position of the surgeon will be found most convenient on the right side of the limb, so that he may grasp it with the left hand above the place of operation. The skin and muscles are to be well drawn upward by an assistant, who at the same time renders the limb steady. The surgeon

carries the amputating knife below and around the limb, and divides the integument down to the fascia, with one circular sweep of the knife, as in the amputation of the leg. The skin and adipose tissue are to be still further retracted by the assistant, and such bands divided as oppose their ascent; or, what is still better, dissected up for the space of two or three inches and turned back in the form of a cuff. For though the ample provision of skin can in no manner prevent the tendency to the formation of the conical stump—that depending on the division of the muscles—it is well understood that there ought to be enough to freely cover the wound, in order that cicatrization may go on rapidly. The muscles are next to be divided circularly at the base of the elevated skin down to the bone, or the cut must at least extend down to the deep-seated group. The superficial muscles are now to be retracted upwards; this is to be done with the fingers of the assistant, especially if the tourniquet has been applied, which by pressure interferes with their tendency to spontaneous contraction. By a third circular sweep of the knife, the deep-seated muscles are then to be divided on a level with the retracted end of the first set. A two-tailed linen retractor is next to be applied, and the tails crossed on the cut surface above the bone. The assistant, laying hold of the ends, draws the divided mass strongly upwards. The surgeon divides with a circular turn of the knife any fibres yet remaining attached to the bone, and saws the latter four inches above the point, at which the first incision was made in the skin. If there be any fear that the deep-seated muscles are not cut sufficiently high, we may run a scalpel round the bone, in the manner of B. Bell, so that they may be drawn an inch still further upwards with the retractor before the saw is applied; or we may follow the advice of Sir C. Bell—raise the limb to the vertical position, which exposes a greater portion of the bone, and apply the saw horizontally. Some little care is to be observed in dividing the bone, in order to prevent the splintering of the little crest found on its back part. If any prominent spiculæ are left, they are to be removed with the cutting pliers. If the great sciatic nerve is left unduly prominent, so as to involve the risk of its being compressed against the end of the bone, it must be retrenched by a second incision.

Dressing.—The arteries to be tied will vary in number according to the height at which the operation is performed. After these are secured, the soft parts are to be brought down with the palms of the hands, and if the operation has been well done, the end of the bone, as observed by Sir C. Bell, will be hidden by the central mass of the muscles. The sides and lips of the wound are then brought together, so as to form a transverse line; or, which I think still better, in a direction obliquely from above downwards, and secured in the usual manner with adhesive straps and a roller bandage.

Flap method.—When the tissues on one side of the limb have been destroyed by injury or disease, the thigh may be successfully amputated by a single flap taken from the anterior surface,—which is to be preferred, as it allows the flap to fall by its own weight upon the face of the wound,—or if need be either from the posterior or lateral. Under other circumstances the double flap operation will be found the more appropriate.

The double flap method will be found to present more advantages for amputation in the upper part of the thigh than the

circular, in consequence of the greater facility with which the flaps may be kept approximated, as the shortness of the stump renders the dressing more difficult after the circular operation.

By two lateral flaps.—These may be made by transfixion from the anterior to the posterior part, and cutting out to the surface, as practised by the French surgeons; or they may be raised by incisions in the opposite direction, cutting from the skin towards the bone, after the manner of Langenbeck. Whichever plan is pursued, the operation is done so nearly like the processes already described for the arm and leg, that it is not necessary to repeat the description. The only important modification is that of inclining the knife so as to cut the flaps larger on the posterior part of the limb than the anterior, in order to allow for the greater shortening of the muscles in the posterior region. The surgeon may form first, either the inner or outer flap, as is most convenient to him, provided the circulation is well commanded with a tourniquet at the upper part of the thigh, or by pressure on the artery over the pubis.

In the operation by two lateral flaps there is a strong tendency (which by great care in the dressing may partially be obviated), in the end of the bone to approach too nearly the anterior angle of the wound, partly from its rising upwards under the action of the muscles inserted on the trochanter minor, and partly from the retraction of the posterior margins of the flaps towards the hip.

For these reasons preference is commonly given, in this country and in Great Britain, to the formation of flaps in the opposite direction, by a lateral or oblique transfixion of the thigh, leaving the posterior flap considerably longer than the anterior, in order to compensate for the greater tendency to contraction in the posterior—the operator standing on the outer side of the limb.

Anterior and posterior flaps.—*Process of Liston.* (Pl. XLIII. fig. 5.)—"The surgeon places himself on the tibial side of the right limb, on the fibular side of the left; and everything being ready, he lays hold of the soft parts on the anterior aspect of the bone, lifts them from it, enters the point of his knife behind the vena saphena, in operating on the right side, passes it horizontally through to the bone, carries it closely over the fore part, and brings out the point on the outward side of the limb, as low as possible: then by a gentle and quick motion of the blade, a round anterior flap is completed. The instrument is again entered on the inner side, a little below the top of the first incision, passed behind the bone, brought out at the wound on the outside, and directed so as to make a posterior flap a very little longer than the former. The anterior flap is merely lifted up after it is formed; but now that both have been made, they are drawn well and forcibly back, whilst the surgeon sweeps the knife round the bone, so as to divide smoothly the muscles by which it is immediately invested. The bone, grasped by the left hand, is sawn close to the soft parts, the saw being directed perpendicularly. The femoral artery will be found on the posterior flap, is tied along with the other vessels, and the stump is treated as recommended after the other amputations. Great care must be taken, during the securing of the vessels, and in steadying the bone for that purpose, not to injure the medullary web; to this cause may often be attributed inflammation and consequent necrosis. The proceeding is, in all respects, the same on the left limb, only the incisions are commenced from the outer side. After the lapse of six or eight days, or sometimes

earlier, a roller should be applied and made to embrace the whole face of the stump, in order to cause reduction of any œdematous swelling that may remain, and bring the parts into a good form. This is the only interference with the part after the first dressing, and is unattended with pain.”*

The *mixed method* and the *oval method* have both likewise been employed in the amputation of the thigh—but not as yet to a sufficient extent to prove that they possess any peculiar advantages over those already described, which have been sanctioned by general experience. The process for employing the *mixed method*, as given by Baudens and Sedillot, is as follows. Cut by transfixion two small lateral flaps, which shall involve only the superficial layer of muscles; draw them upwards and divide circularly at their base and at the same time sloping upwards the deep-seated muscles down to the bone, so as to leave a conical hollow, at the upper part of which the bone is to be cut. The *oval process*, as described by Malgaigne, consists in making an oval or rather elliptical incision of the skin—one extremity of which oval rests on the anterior and outer portion of the thigh, and the other at the posterior and inner part, an inch and a quarter lower down than the former. The skin is to be dissected up, and the surgeon proceeds precisely as in the common circular amputation, with the exception that both layers of muscles are to be divided in the same manner as the skin—obliquely from above downwards. The sole object of this method is to divide the muscles on the back part of the limb lower than those in front, so that after their retraction the stump may be left square and even. The principle involved in this method seems well founded in the anatomical structure of this limb, and I have applied it in one instance myself with a most happy result upon the living subject.

AMPUTATION AT THE HIP JOINT.

Amputation at the hip joint, though by no means very difficult, is undoubtedly to be classed among the most severe and dangerous surgical operations. The idea of attempting this fearful mutilation originated with Morand in the early part of the eighteenth century. Since that time fifty-four cases in all have been recorded of the operation, of which nineteen only have been claimed as successful. Though it may be difficult to collect the true statistics in regard to this amputation, the danger attending it may be well understood when we consider the extent of the wound necessarily inflicted; the huge mass of divided muscles; the difficulty of effecting union by first intention at the part; and the shock to the nervous system—which has in some cases been almost immediately fatal—arising from the loss of a limb which represents nearly a fourth part of the whole structure of the body. It may be important, however, to observe, that nearly all the successful cases have been those in which the operation was practised for traumatic injuries, and almost immediately after their infliction; while the greater number of fatal results were consequent to the operation on subjects previously exhausted to more or less extent by disease. Still the surgeon may in some cases be justified in performing it as a last resort, under circumstances analogous to the following, which have been laid down by Barbet in a prize memoir as the indications for the operation;

viz.: where from sudden violence, as by gunshot wounds, or crushing from machinery, a comminuted fracture is produced of a healthy bone at its head, neck, or upper part; where the limb is carried away or extensively injured by a cannon shot near the trunk; or where gangrene has so far extended, or threatens to extend its ravages, as to render it impossible to obtain a sufficient covering of the stump by other means. And to these, as the principal cases in which the operation is likely to be attended with a favourable result, have been added those for which excision is recommended in other joints—caries, necrosis, osteo-sarcoma, spina ventosa, or other incurable affections beyond the chance of relief by amputation in the continuity of the thigh. But in regard to this latter class it is almost indispensably necessary, in order to render the operation justifiable, that the diseased action should be limited to the head of the femur, and not have invaded the structure of the pelvic bones. But the extreme difficulty of determining this point beforehand, and the rareness in fact of such limitation in caries—the more common disease of the part—must restrict its performance in the hands of careful surgeons to very narrow grounds. If, however, after the operation has been undertaken, the surgeon should find the margins of the cotyloid cavity carious or necrosed, he would be justified in removing them, as in resection, with the cutting forceps, gouge, or chisel, before closing the wound. The operation has, nevertheless, been recommended for caries of the head of the bone following coxalgia. In a case said to be of this description, its removal was successfully effected by Dr. J. W. Duffee, of this city. But the observations of Mr. Pott, who witnessed a like operation by Mr. H. Thompson, the first that was ever performed, are in the main so just in reference to the practice, that they can scarcely fail to meet the sanction of every practitioner familiar with surgical pathology. He observes, “that the parallel which is drawn between this operation and that in the shoulder will not hold. In the latter it sometimes happens that the caries is confined to the head of the os humeri, and that the scapula is perfectly sound and unaffected. In the case of a *carious* hip joint this is never the fact; the acetabulum and the parts about are always more or less in the same state, or at least in a distempered one, and so indeed are most frequently the parts within the pelvis.”*

Surgical anatomy of the joint.—The hip joint, which is everywhere surrounded by muscles, can only be felt in the anterior region of the thigh, where the head of the femur, covered by the tendon of the psoas and iliacus internus muscles, forms a globular prominence under Poupart’s ligament. On its outer side lies the rectus muscle, which crosses the neck of the bone, and behind and within lies the great muscular mass of the limb. The crural artery crosses the joint on a line with the junction of the internal with the middle third of the head of the femur, but only becomes parallel with the bone at a distance of three or four inches below, leaving between it and the greater part of the neck the space of at least an inch. The profunda descends in nearly the same antero-posterior line. Space is thus left for the safe passage of the knife in some of the processes for amputation, as well as for the seizure of the trunk of the vessels in the internal flap. The position of the joint may be determined with considerable precision by the following rules.

* Liston’s *Prac. Surg.*, Am. ed., p. 383-4.

* Pott’s *Surgery*, vol. III. p. 374.

1. If we draw an imaginary line between the anterior superior spine of the ilium and the tuberosity of the ischium, it will cut the cotyloid cavity a little behind its middle.

2. If we drop a vertical line an inch and a quarter long from the anterior superior spinous process of the ilium, the external and upper portion of the joint will be found half an inch to the inner side of the termination of the line.

3. If we draw in like manner a line half an inch long from the anterior inferior spinous process, its extremity will rest on the superior part of the joint.

4. The great trochanter is superficial and easily felt: it takes a direction upwards and inwards, and is then turned a little backwards. It forms a prominence about half an inch or a little more above the neck of the femur, and a line drawn horizontally from its top crosses the upper third of the joint.

5. The trochanter minor projects nearly half an inch from the inner side of the bone, so as to form with its upper surface nearly a right angle with the axis of the shaft. Its under surface is about an inch long, and is continued obliquely into the shaft, with which it forms an angle of about 50 degrees, opening upward.

6. When the patient is lying on his back, the tuberosity of the ischium will be found to project an inch and a quarter in advance of the margin of the acetabulum, a fact of much importance to remember, especially in the transfixion for the purpose of forming flaps.

The acetabulum or cotyloid cavity is about two inches in diameter, and is inclined obliquely downward, inward and forward. The spherical head of the thigh bone is of equal size; a large part, especially of its posterior portion, is received into the acetabulum—but it is not entirely sunk in the socket. The capsular ligament, which is very thick and strong, springing above from the margin of the acetabulum, covers the remainder of the head, and shrinks closely round it to embrace the narrow neck upon which it is inserted. If, in the disarticulation, the ligament is divided round the neck, the head still remains fast closed within its cavity; and hence the rule always to divide it over the circumference of the head of the bone. The interarticular or round ligament, which connects the top of the head to the corresponding portion of the cavity, is put on the stretch when the thigh is abducted, and presents itself to the knife over the inner edge of the socket. Hence, the most favourable point for opening the capsule to effect luxation of the head, is on its inner and lower portion. The surgical neck of the bone is about an inch and a half long, and occupies the space between the trochanter and the head; it is directed downward and outward, and affords room on its sides for the passage of the knife in amputation. At its base, the knife becomes arrested against the trochanter of either side, around which it must be made to turn, except the subject be under twelve or fifteen years of age, when these processes are found so cartilaginous as to be readily divided. From the position which, as has been shown, the muscles occupy about the limb, it would be impossible to split them into two equal flaps, unless we could pass the knife from the anterior spine of the ilium to the tuberosity of the ischium. As this cannot be done, the internal flap must be made much the larger of the two; and it is well to remember, that the muscles are cut short and will not therefore diminish much in length.

The operation is performed by the different methods—flap, circular and oval. Some fifteen different processes have been devised for this disarticulation; but it will only be necessary to detail those which are most esteemed.

Flap method.

This method is the most ancient, and has in consequence been practised the greatest number of times. It may be done with the single or double flap.

The patient is to be placed either on the back or the opposite hip, according to the process employed, resting upon a stout narrow table, which should be covered with a couple of pillows and a folded blanket. The pelvis must be advanced so as to extend a little over the edge. Several assistants will be required in order to steady the patient and assist in the operation. One secures the pelvis and keep the trunk from slipping downwards and forwards; one sustains the shoulders so as to prevent the patient's rising; another holds the diseased limb, (that of the opposite side being secured to the leg of the table, or held by the assistant who secures the pelvis,) and a fourth controls the circulation by pressure on the artery above the groin, and holds himself in readiness to raise the first flap. In the earlier accounts of the operation, it was recommended as a proper precaution against hemorrhage, to make a previous ligature of the femoral artery, close to Poupart's ligament and above the origin of the circumflex and profunda. This method of proceeding is deemed by many unnecessary and superfluous, as the circulation may effectually be controlled by pressure over the pubis, or in the thickness of the flap; but it was strenuously inculcated by Larrey, and is still advocated by Blandin and others. It does not, however, in any way compromise the chance of cure; and as it effectually guards against hemorrhage from this large trunk, it is a step which I believe should always be taken when an assistant is not at hand on whom implicit reliance can be placed, or when the patient is already weakened so as to render it important to prevent as far as possible all effusion of blood—leaving, as it does, another hand of the assistant free to close the mouths of the larger arteries (which come from the back of the pelvis), on the surfaces of the flaps, until they can be secured with ligatures. From the anatomical arrangement of the parts, it is difficult to apply any form of tourniquet that shall securely compress the vessel without presenting too much embarrassment in the way of the operator.

Double flap, formed from the outer and inner sides of the limb. Process of Lisfranc modified. (Pl. LXIV. fig. 3.)—The surgeon stands on the outer face of the thigh, or by the side of the trunk, according as he is to operate on the left or right limb. The assistant holding the limb, flexes it slightly on the pelvis.

1. *Formation of the outer flap.*—The surgeon then, having all his assistants placed, and fixing in his mind the relation of the different parts, enters perpendicularly the point of a stout but narrow double-edged knife, ten inches long in the blade, on the outer side of the neck of the femur, with the lower edge looking towards the summit of the trochanter major. The point of the knife should graze the neck of the bone, or rather the top of the trochanter; and as it advances towards the inferior surface of the limb, the handle must be inclined upwards and outwards, so as to form behind with the axis of the trunk (which is supposed to be

horizontal) an angle of 50 degrees, in order to bring out the point half an inch below the tuberosity of the ischium—the surgeon with his other hand, or an assistant, drawing outwards at the same time the mass of flesh on the posterior part, so as to allow the knife to penetrate more within and give greater dimensions to this outer flap. The surgeon, still holding the flesh outward, keeps the knife in the same state of inclination, and by a sawing motion, brings it down over the outer face of the great trochanter, and raising the handle, shaves the thigh bone for two inches, and cuts directly outwards so as to complete the external flap. The flap is to be raised by the assistant, and the divided gluteal and ischiatic arteries either immediately tied or secured temporarily by pressure with the fingers, or compressed after the manner of Baudens, with a couple of pair of artery forceps, which are left pendent.

2. *Formation of the inner flap.*—The surgeon inclines the soft parts inwards with the left hand, enters the point of the knife at the top of the first incision, and carries it on the internal side of the neck of the bone, with the handle inclined as before towards the abdomen of the patient, so as to bring the point out at the posterior angle of the wound without touching the bones of the pelvis. The knife is now raised perpendicularly to the horizon, by bringing the heel downwards so as to shave the neck of the bone—but without carrying backwards the point; it is then made to cut directly towards the surface of the trochanter minor, and shaving the internal side of the bone is brought out so as to finish the internal flap at the same height as the outer, leaving a V shaped portion of skin remaining on the front of the femur. As soon as the structures during this incision are sufficiently loosened from the neck of the bone, the surgeon is to pause for a

PLATE XLIV.—AMPUTATION AT THE HIP JOINT.

(Fig. 1.) PROCESS OF BARON LARREY. (*A mixed process between the oval and circular, shown upon the right leg, with a previous incision to secure the femoral artery.*)

A longitudinal incision (*a*), commencing just below Poupart's ligament, is made over the track of the femoral vessels, which are to be tied temporarily over a strip of linen, cut below the knot, and reversed as seen at *b*; the ligature by which they are drawn up being secured to the surface by a strap of adhesive plaster, and the fingers of an assistant (*c*), to keep it out of the way of the knife. The surgeon then takes his position on the inner side of the limb, and divides the integuments with an oval sweep of the knife round the limb, leaving them the longest on the posterior face of the limb, as described in the text, and showed by the outline (*e, g*). The oval section commences on the outer side (*d*), at the lower end of the longitudinal cut (*a*), and the knife, in the right hand of the surgeon (*f*), is brought round posteriorly and up again in front to the place of beginning, as shown in the drawing. The genital organs are to be drawn by a compress towards the opposite groin, so as to be out of the way of the knife. The subsequent steps of the operation are described in the text.

(Fig. 2.) PROCESS OF M. CORNUAU. (*Oval process.*)

A vertical incision has been first made from over the joint down to the trochanter. This incision is then branched below like the letter Λ inverted, according to the modification of M. Malgaigne, the course of the anterior branch being from *a* to *b*, the posterior from *a* to *c*. Through the lips of this double incision the surgeon proceeds to open the joint and disarticulate the head of the femur. Then gliding the knife under and to the inner side of the head of the bone, he brings it down to the extremities of the Λ incision made in the skin. An assistant, as soon as sufficient space is obtained, grasps the femoral vessels in the thickness at the inner lip of the wound. The surgeon now continues the course of the knife, (as seen in the drawing, where it has already cut a great part of the large internal oval flap,) holding the handle in a direction inwards and downwards, so as to cut out on the posterior part of the leg, and give the greatest length to the inner part of the covering for the stump.

d. Hand of an assistant, compressing the femoral vessels.

e. Left hand of the surgeon, controlling the movements of the limb.

f. Knife, employed in his right hand.

g. Acetabulum, from which the head of the femur (*h*) is detached.

i. Branches of the first Λ incision continued down through the soft parts, on either side of the trochanter major, to reach the capsule of the joint.

k. Section of the mass of abductor muscles.

(Fig. 3.) PROCESS OF LISFRANC. (*Double flaps.*)

The process of Lisfranc is shown somewhat modified, for the purpose of obviating the difficulty which attends the turning of the knife round the trochanters, leaving on the external and anterior part of the limb a V shaped flap, with the base towards the knee. The stage of the operation shown, is the *disarticulation of the femur*.

Fig 1

Fig 2



moment (provided the artery has not been previously tied) in order to allow the assistant to introduce his thumb or fingers for the purpose of compressing the vessels at the base of the flap. This flap, as soon as completed, is also to be raised.

3. *Disarticulation*.—The surgeon grasps the thigh with the left hand, and presents the edge of the catling or a stout scalpel vertically at the inner side of the head, which he circumscribes as far as possible, dividing the capsular ligament without attempting to penetrate into the joint, *as if about to cut the head of the bone in two, and leave one-half in the cavity of the acetabulum*. The limb is now held in a state of abduction, and the point of the knife carried into the open joint to divide the round ligament. The knife is next placed vertically on the inner side of the joint, and the remaining portion of the capsule, and the few muscular fibres left uncut, are to be divided from within outwards and downwards.

The process as described differs a little from that of Lisfranc, inasmuch as it leaves a Λ shaped piece of skin in front—the consequence of carrying the knife directly from the neck of the bone to the top of the two trochanters; the directions of Lisfranc being to carry the knife along the fossa so as to turn round the tip of the trochanters, which can scarcely be done especially for the outer flap, without haggling the skin both at the top and bottom of the incision. By the processes described above, the operation is perfectly easy, and the removal of the Λ shaped piece is found rather a benefit than disadvantage in the subsequent approximation of the flaps.

If the artery be thoroughly compressed or previously tied, the operation may be done by forming the internal flap first, disarticulating the bone and then carrying the knife through the joint in order to cut a second flap on the outer side.

Flaps formed from the anterior and posterior parts of the thigh. Process of Beclard as modified by Liston and Fergusson.—This is in general to be preferred to the operation by lateral flaps, as it is quite as readily performed, and from the fact of its splitting the muscular mass of the thigh in its narrowest diameter, does not leave so deep and extensive a wound, and furnishes flaps which are more readily kept in juxtaposition by the dressing. The femoral artery will, however, be divided in the first step of the operation.

“The surgeon, standing on the outside of the limb, should insert the point of a long catling about midway between the an-

terior superior spinous process of the ilium and trochanter major, keeping it rather nearer the former than the latter; he should then run it across the fore part of the neck of the bone, and push it through the skin on the opposite side, about two or three inches from the anus; next, he should carry it downwards and forwards, so as to cut a flap from the anterior aspect of the thigh, about four inches in length. When the blade is entered, the limb should be held up, and even slightly bent at the joint; the instrument will then pass along more readily than if all the textures were thrown on the stretch, and moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of the fibres, if not the whole, of the iliacus internus and psoas muscles. As the knife is carried downwards, the assistant, who stands behind the operator, should slip his fingers into the wound and carry them sufficiently far across to enable him to grasp the femoral artery between them and the thumb: this he may do from the inside or outside at will, and with the right or left hand as may be most convenient, the same grasp enabling him to raise the flap as soon as it is completed. * * * * The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any textures in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start from its socket, and if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forwards, to allow the knife to be slipped over it. * * * * The knife should then be carried downwards and backwards in the course of the line, so as to form a flap somewhat longer than in front, the last cut completing the separation of the limb.

“By means of the fingers of assistants (and here one or two more than those referred to may be of service), and the application of sponges, the bleeding may in some degree be restrained until ligatures are applied. If the vessels seem large on the posterior flap, it will be best to secure them first, and then the femoral and such other branches as may require ligature in the front flap should be attended to. If, however, there is any fear of the main vessel eluding the grasp of the assistant, there will be greater safety in tying it first. If, in making the anterior flap, the knife

The surgeon has first transfixed the limb on the outer side of the joint with a long catling, as described in the text, formed the external flap (*a*), and tied the ischiatic and gluteal arteries on its bleeding surface. Secondly, he has passed the knife on the inner side of the head of the femur, and formed the large internal flap (*d*), an assistant gliding his hand into the track of the knife, so as to compress the femoral artery before it is divided in the completion of the flap. The bleeding vessels on the surface of this flap are then likewise to be tied. In the last step of the operation the flaps are raised by an assistant, the surgeon opens the capsule with the point of the knife, abducts the limb, as shown in the drawing, so as to divide the round ligament, and finally carries the knife round the head of the bone to detach the limb by cutting the remaining part of the capsule.

b. Small triangular or V shaped flap, left between the two incisions.

c, e. Ischiatic and femoral arteries, tied.

f, g. Hand of an assistant, sustaining the internal flap while the surgeon disarticulates the bone.

h. Left hand of the surgeon, grasping the thigh so as to make the proper changes of position to favour the action of the knife (*i*).

is kept close to the femur for some way down, the superficial femoral will not be divided until the incision is nearly completed, and this branch with those of the profunda may all be sufficiently compressed whilst the hand is used in the manner above described.”*

Mr. Guthrie directs the *anterior* and *posterior* flaps to be formed in a somewhat different manner. He divides at first the integuments only—on the inside and then on the outside of the limb—from a point in front of the spinous process of the pubis, to another point near the tuberosity of the ischium, where the incisions are again to meet. The skin is raised and reflected on each side, and the muscles cut at the base of the fold from the surface to the centre obliquely upwards towards the articulation. An obvious advantage obtained by this process of Mr. Guthrie, is that of leaving more integument and less muscle in the wound, disposing the parts better for reunion, which, in an operation of such magnitude as this, is a consideration of greater importance than the facility of its performance.

Single flap.—The operation with a single flap is the only one that can be performed in certain cases, when the soft parts have been impaired on one of the surfaces of the limb. The flap may be taken from the anterior and internal, or internal and posterior parts of the limb, but the anterior and internal is to be preferred when admissible, as the flap will then fall by its own weight upon the surface of the stump, afford a ready outlet below for the pus, and leaves a chance of cure as good at least as that by any other process. The flap must be cut at least eight inches in length, and rounded at its extremity, to suit the form of the limb. If taken from the posterior part of the limb, in order to keep it well applied upon the surface of the stump, a matter of considerable difficulty, it should be secured with the twisted suture to the integument of the opposite side, as well as supported with the ordinary dressings. The flap may be first formed by transfixion and cutting outwards, then opening the joint and carrying the knife around the bone so as to divide transversely or with such obliquity as the state of the parts will allow, the tissues on the opposite surface of the limb. Or an incision may at once be made on the outer side of the thigh, so as to expose the joint, and terminate near the tuberosity of the ischium; the joint opened from the outer side, and the flap cut last upon the anterior and inner face of the limb.

Dr. Wm. Ashmead, of this city, prefers to cut the anterior and internal flap first, by an incision from the surface towards the joint, and has suggested the important modification of first dissecting up the skin so as to tie the artery before proceeding to the section of the muscles.

Circular Method.

The circular method, as well as the plan of arresting the circulation by pressure over the pubis, was first proposed by Abernethy for amputation at this joint. It has subsequently received the sanction of many eminent surgeons, and every one who has amputated the thigh so high as to divide the bone through the trochanters, must be made aware of the possibility with which by this method the soft parts might be separated from the neck, and the head itself detached from the joint.

The process is so nearly similar to that for circular amputation

in the continuity of the bone, described at page 172, that it will not be necessary to give it in detail. The parts divided will not, however, be precisely the same, and it will be necessary to control the circulation by pressure on the femoral artery above the pubis. The retraction of the muscles is also less in this region, and it is therefore usual to divide them with a single cut down to the bone. Graefe preferred to hollow them out in the form of a cone, with a concave knife, broad toward the point. The lips of the wound are to be closed in a line from above downwards with adhesive straps.

Mixed method. Process of Larrey. (Pl. XLIV. fig. 1.)—This process, which has been received with considerable favour, cannot properly be classed under either of the three more common methods. It consists of an ovoidal section of the skin, with a division of the muscles into two lateral flaps. The surgeon, standing at the inner side of the thigh, begins with a vertical incision over the course of the vessels, in order to make a previous temporary ligature of the artery and vein over a strip of linen or some similar material; he then divides the vessels, and has them drawn upwards as shown in the plate. The skin of the thigh is next to be divided nearly circularly on a line with the lower end of the incision, dissected from the fascia and turned upwards. The long catling is now to be entered on the internal side of the neck of the bone, half an inch below the pubis, and carried through in the usual manner, so as to cut the internal flap first. This is to be raised up, the capsular and round ligaments divided, and the knife carried round the joint and brought down on the outer side so as to complete the second flap.

Oval method.

This is but of recent invention, and has in consequence been only a few times applied upon the living subject. It is of easy execution, and leaves a linear wound well disposed for union.

Process of Cornuau as modified by Malgaigne. (Pl. XLIV. fig. 2.)—The patient rests upon the hip of the other side, the pelvis is brought to the edge of the table, the artery compressed above the pubis by one assistant, and the limb—extended and slightly abducted—supported by another.

The surgeon, standing behind the patient, rests three fingers of the left hand on the top of the trochanter major, makes a *first* incision from a point three-quarters of an inch above the trochanter directly downwards for three and a half inches below this projection, cutting to the bone. From the lower end or the middle of this incision, according to the size of the limb, a *second* incision is carried obliquely in front, to a point at which a vertical line brought down from the anterior superior spine of the ilium, would form a right angle with a line drawn horizontally from the tuberosity of the ischium,—cutting in like manner down to the bone,—and leaving the great vessels to the inner side of the end of the incision. A *third* incision down to the bone is started from the same point as the second, and carried obliquely downward and backwards to the inferior border of the gluteus maximus muscle. By raising a little the upper flaps, the articulation will be exposed on its anterior, external and outer surface; divide then circularly the capsule over this space, luxate the head of the femur, cut the round ligament, and carry the knife round the head so as to divide the inner portion of the capsule and descend upon the neck. An

* Fergusson's Practical Surgery, Am. ed., p. 391–393.

assistant is next to pass the thumb or fingers above the knife so as to compress the femoral artery between the surface of the wound and the skin; and the surgeon, grasping the thigh with the left hand, carries the knife down the inner face of the bone to the lower angles of the two oblique incisions, and finishes by cutting squarely at a single sweep the remaining soft parts.

Dressing.—By whatever process the operation is done, the assistants should compress as much as possible the bleeding orifices of the large vessels, until there is time to secure them with the ligature. On the inner side of the limb will be found the femoral artery, the profunda commonly, and the branches of the

obturator and circumflex. On the outer and back part of it are the ischiatic, and the branches of the gluteal and internal pudic. The lips of the wound are to be brought together (to form, if the process will allow it, a line, oblique from above downwards and from without inwards), and secured with adhesive straps and a few points of the interrupted or twisted suture. The ends of the ligatures are to be brought out at the lower angle, in which should also be lodged a greased linen compress, to maintain a free outlet for the discharges. A roller bandage may be applied round the pelvis, and a few turns brought over so as to support the divided soft parts.

PART THIRD.

SPECIAL OPERATIONS:

OR THOSE WHICH ARE PRACTISED UPON COMPLEX ORGANS IN PARTICULAR REGIONS OF THE BODY.

UNDER THIS GENERAL HEAD ARE CONSIDERED: OPERATIONS—1. UPON THE EYE; 2. THE EAR; 3. THE NOSE; 4. THE MOUTH AND ITS ACCESSORY ORGANS; 5. THE NECK; 6. THE THORAX; 7. THE ABDOMEN; 8. THE RECTUM AND ANUS; AND, 9. THE GENITO-URINARY ORGANS.

I. OPERATIONS PRACTISED UPON THE EYEBALL AND ITS ACCESSORY ORGANS.

THESE OPERATIONS MAY BE ARRANGED INTO FOUR GROUPS, ACCORDING TO THE PARTS UPON WHICH THEY ARE PERFORMED: 1. THOSE FOR AFFECTIONS OF THE LACHRYMAL APPARATUS; 2. THOSE FOR THE PROTECTING ORGANS OF THE EYE; 3. THOSE FOR THE BALL OF THE EYE; AND, 4. THOSE INVOLVING THE ORBIT, AND THE PARTS CONTAINED WITHIN IT NOT SPECIFIED ABOVE.—THESE GROUPS WILL BE TAKEN UP IN SUCCESSION.

It may be well to observe, that in general the operations upon the left eye are directed to be performed with the right hand, and those upon the organ of the opposite side, with the left—the surgeon standing, in both cases, in front of the patient. But to render the surgeon capable of using the left hand with sufficient precision and adroitness in operations delicate and important as these, it is necessary that he should have practised them very many times, with all their evolutions, upon the dead body. To obviate the inconveniences arising from this want of ambi-dextrousness, surgeons have invented elbowed instruments, so as to allow them to act over the bridge of the nose, and admit of the employment of the right hand in all cases. But such instruments have an awkward appearance at best; and it is much better for the operator, when he has not a perfect mastery over the instruments with his left hand, to place himself either behind or at the side of the patient, who may, if it is found more convenient, be laid horizontal. In this way the right hand may at need be employed in all cases in which he is directed in the processes for the operations to employ the left.

OPERATIONS PRACTISED ON THE ACCESSORY ORGANS OF THE EYE.

Lachrymal apparatus.

Surgical anatomy.—This apparatus is composed of two distinct portions—the orbital and nasal.

1. *The orbital portion.*—The *lachrymal gland*, which is placed between the conjunctiva and bone, at the outer and upper portion of the orbit, throws its fluid by seven or eight minute ducts upon the free surface of the corresponding portion of the conjunctiva. With this lachrymal secretion is mixed the fluid coming from the *meibomian glands*, the *caruncula lachrymalis*, and the free surface of the *conjunctiva*, to form the proper lubricating liquid between the lid and the ball, which, when it flows over the cheek, receives the name of *tears*.

2. *The nasal portion.*—This is composed of parts for the purpose of carrying off the fluid, and preventing in the ordinary state of the functions any of it escaping between the lids, viz., the *lachrymal puncta* and *canals*, and the *lachrymal sac* and *nasal duct*.

The *puncta* are orifices with elastic rims, by which the two canals open on the free surfaces of each lid, near the inner canthus. From these capillary points, the canals run at first for a line, obliquely upwards or downwards, according to the lid in which they are placed, and then turn at a right angle and run for a quarter of an inch—embracing the *caruncula* between them—to open close together through the internal wall of the lachrymal sac, so as to throw into this cavity the fluids which they carry. In all their track, these canals are covered by the orbicularis muscle and the skin, and lined within by a reflection of the conjunctiva, which is thrown, near the angle described, into a

valvular fold that sometimes presents an obstacle to the passing of instruments into the sac.

The *lachrymal sac* is of an oval or oblong shape, with its long diameter directed downwards and a little inwards and backwards. It is lodged in the groove formed by the *os unguis* and the nasal process of the upper maxillary bone. The root of this nasal process, which extends outwards to form the inner part of the lower brim of the orbit, has upon it a projection called the *lachrymal tubercle*, (readily felt when the integuments are not too much thickened,) which is exactly opposite the junction of the inferior with the middle third of the lachrymal sac, and serves as an index to guide the course of the knife in the puncture of the sac. Besides its internal mucous lining, which is continuous with that of the puncta, the sac has an external fibrous tunic, thick and resisting, and closely united to the neighbouring bones. Across and in front of the sac passes the round tendon of the orbicularis palpebrarum muscle, which feels like a grain of rice below its mucous covering, and divides the sac into unequal parts. The superior portion is lodged behind the caruncula, and is covered by a firm expansion of the orbicular tendon. The inferior, which is the larger, is found between them and the lachrymal tubercle; is covered only by a few fleshy fibres and the skin, and yields readily to distension from accumulation of the fluid within. Occasionally, however, we find the whole sac distended, and then the pressure of the round tendon near its middle gives it a bilobular shape. Where it meets the floor of the orbit, the lachrymal sac terminates in the nasal duct, by which in a healthy state of the parts it throws its fluid into the nose.

The *nasal duct* is formed of two membranes like the sac, and is lodged in a delicate and fragile bony canal formed by the inner wall of the maxillary sinus, and a portion of the *os unguis* and inferior turbinated bone. The canal is directed with a double inclination from above downwards; 1st, bending from the perpendicular outwards, so that a probe introduced through it from above crosses at its upper end the middle line of the forehead about an inch above the nasal bone, so as to form with that line an angle of ten or twelve degrees; 2d, the inclination which is backwards causes the probe to form in that direction with the forehead an angle of twenty to twenty-five degrees.

The canal is of equal length with the sac, each being about five lines long, and opens below under the inferior turbinated bone in the lower meatus of the nose. Its inferior orifice, which is beveled at the expense of its inner wall, and looks a little backwards, terminates about half an inch above the floor of the nostril. The whole space *from the floor of the nostril to the top of the sac* varies from an inch to an inch and a quarter, and the nasal duct occupies about the middle third of this space. The calibre of the duct is smallest in its middle part, where it is circular, and has a diameter of little more than a line; at its upper and lower termination, it is larger by half a line, and somewhat oval, so that in shape it resembles two small cones joined at their summits. The diameter of the healthy *lachrymal sac* is about the sixth of an inch.

Lachrymal tumour and lachrymal fistula.

These two affections, which are often treated of as separate

morbid conditions, are in fact but different stages of the same, and in many cases have for their origin a chronic affection of the mucous membrane of the eye or nose, which has spread by continuous sympathy along the adjoining passages for the tears, so as to involve the lining membrane of the lachrymal sac. Caries of the *os unguis*, exostosis of the bony passage for the nasal duct, pressure from polypous tumours, and analogous affections, frequently occasion it; and it sometimes seems to arise from primitive inflammation of the sac from the common causes which affect the other mucous membranes. In some few instances, of which one has come under my notice in the case of a young architect of this city, it has been owing to a congenital deficiency of the nasal duct.

A lachrymal tumour is a collection of fluid within the cavity of the lachrymal sac, forming a rounded elevation of the integument at the internal canthus of the eye. This is at first a mere passive swelling, without redness or pain, and may be emptied by pressure with the finger upon it, the contained fluid escaping upwards by the lachrymal puncta, as is most common, or downwards by the nasal duct. In this state the tumour will often remain for months or even years, giving rise to but little inconvenience except that occurring from the necessity of occasional pressure on the sac in order to empty it of its contents, and a flow of tears (*epiphora*) over the face, when the eye is exposed to causes a little more than usually excitative of the secretion, as exposure to bright light, or going from a warm room into the open air when the latter is cold and sharp. Under such circumstances the distending liquid may consist merely of the lachrymal fluid mixed with mucus, or with a puriform secretion from the surface of the sac. Sooner or later, however, this catarrhal state of the parts, if not relieved by appropriate treatment, is followed by acute phlegmonous inflammation. The tumour enlarges more, becomes highly painful and red, can be no longer entirely emptied by compression, and the fibrous or outer membrane of the sac and the integument covering it, if not opened with the knife, ulcerate so as to give exit to the fluid within, which will then be found purulent. A complete lachrymal fistula is now formed. In some cases an internal fistula is developed; the *os unguis* becomes softened and ulcerates, and allows the fluid to escape into the nasal cavity. This result sometimes follows as a secondary effect after the external opening has been formed through the skin; and if the external orifice should then close up by cicatrization, a cure may be produced by the efforts of nature alone. The occasional occurrence of a cure in this way has led to the institution of processes, in order to effect artificial relief in a manner somewhat analogous.

The cause of obstruction will commonly be found in the nasal duct, and, though this may occasionally be of a physical nature, it is important to remember that in a vast majority of cases it is simply owing to an inflammatory swelling or thickening of the lining membrane, and amenable to the common methods of treatment for strictures of the other narrow mucous canals; viz., such general remedies as are used in local inflammations—topical bleeding, purgation, and discutient applications,—and those that are used locally—injection, catheterism, compression, to which some have added cauterization. Of the latter class of remedies only, as coming within the scope of this work, we shall proceed to treat.

TREATMENT OF LACHRYMAL TUMOUR AND LACHRYMAL FISTULA.

It has already been observed, that the inflammatory thickening of the lining membrane of the lachrymal passages, is in its first stage the cause of the watery eye and the discharge of tears over the cheek; in its second, of the formation of a tumour in addition, in consequence of the distention of the lachrymal sac; and that in the third stage of the disease, the tumour is opened by ulceration so as to form a lachrymal fistula.

The mode of treatment of the first and second stages will be very nearly the same, and may be divided into the medical and surgical. When the medical treatment—which consists of the application of mildly stimulating ointments and collyria to the conjunctival membrane for the purpose of altering the character of its secretion, the use of local bleeding, (and of venesection, if there be any arterial excitement,) the application of emollient poultices, and the administration of alteratives and cathartics—have been fairly tried without effecting a cure, we proceed to the employment of surgical measures. These consist of injection, catheterism, and compression.

Injections through the puncta.

Process of Anel. (Pl. XLV. fig. 3.)—The instrument required is a small syringe attached by its beak to a capillary tube. The patient is to be seated in front of a good light, and the surgeon holds the syringe in his right hand so as to be able to force down the piston with the thumb or fore finger, the other hand being left at liberty to act upon the lids. In case the puncta should not be found patulous, a common toilet pin, with the point a little blunted, may be used to dilate the orifice.

1. *Injection by the lower punctum.*—With the fore finger of the left hand, depress the lower lid opposite the punctum, so as to reverse it and expose the orifice. Taking the syringe in the other hand, and resting the two smaller fingers below the superciliary arch, insinuate the end of the capillary tube through the orifice of the punctum obliquely from above downwards and backwards, so as to bury it to the extent of a line. It has now arrived at the turn of the lachrymal canal, and the instrument is to be inclined downwards in order to efface the curvature, and make the point of the tube take the ascending direction of the canal. The tube is now to be passed on half a line farther, and the piston pushed gently down with the thumb or finger, to throw the fluid forwards. Some surgeons direct the capillary tube to be buried for a quarter of an inch, so that it may enter the sac; but this does not increase the facility of injection, and exposes the lining membrane of the sac to irritation from the point. When assured by the flow of the fluid from the upper punctum that the superior canal is free, pressure may be made upon its orifice by an assistant, or with the fore finger of the other hand of the operator, so as to cause the fluid to accumulate in the sac, and find its way by the nasal duct into the nostril. Its entry into the latter cavity will be made known by the trickling of the fluid forwards upon the lip, or by its passing backwards into the pharynx, so as to produce an effort to swallow; the one or the other result following according to the degree of inclination which is given by the position of the head to the floor of the nostril.

2. *Injection by the upper punctum.*—The upper lid is to be ele-

vated with the thumb of the left hand; the fingers resting upon the forehead. The mode of introduction of the tube in this case, is in all respects similar to the process just described, except that the two last fingers of the right hand are to rest on the cheek bone, and that the instrument is to be raised in order to pass the point of the tube beyond the angle, as the course of the canal on the inner side of this curvature is from above downwards.

Remarks.—The injection by the lower punctum is almost the only process employed—the injection through the upper, being chiefly resorted to only in cases where some obstruction is met with in the passage of the lower lid, or there is fear of irritating it by too frequent repetition of the process. It is directed by many surgeons to hold the syringe in the right hand for the eye of the right side, and in the left hand for the other. But the operator will find it perfectly easy, by placing himself either in front or behind the patient, to employ the same hand for the eye of either side.

The fluids for injection may be simply aqueous or mucilaginous, if we wish merely to wash out the irritating contents of the sac and soothe the lining membrane of the passages; or they may be medicated by the addition of a few drops of the wine of opium; or with the sulphate of zinc, in the proportion of a grain or more to the ounce, or of corrosive sublimate, or lunar caustic in that of a half to one and a half grains to the same quantity of the fluid.

It is by its tendency to remove inflammation rather than by the force of distention, that we may hope by this means to restore the free passage of the tears into the nose. But from the rude manner in which it is too commonly practised, it is not perhaps too much to say, that this process of Anel, which by proper management and repeated at intervals of not less than one or two days, may be occasionally rendered useful, has on the whole been productive of more injury than good. Many practitioners have in consequence abandoned its use altogether, and rely for the introduction of fluids into the sac upon the natural process of absorption through the puncta, first pressing upon the sac so as to evacuate its contents, and then introducing an astringent solution between the lids.

In many cases the fluid will not find its way into the nose until the injection has been frequently practised, and in some others, before it can be effected at all, it will be necessary to resort to one of the following operations in order to remove the obstruction in the nasal duct.

Catheterism, or the introduction of a solid sound or hollow catheter through the lachrymal passages.

1. *From above downwards by the upper lachrymal punctum.*
Process of Anel.—The patient is to be seated, with his head inclined backwards and rested against the chest of the surgeon, who stands behind him. The operator then raises the upper lid with the end of the fore finger, and inserts into the punctum the rounded head of the delicate probe of Anel, in the same manner as directed for the tube in the process for injection. Having passed it beyond the curvature, he lessens the traction with the fore finger upon the lid, and carries the probe downwards into the sac, following the direction of the canal, and rendering in consequence the skin tense toward the root of the nose. On its arrival at the sac, a result which will be known by the extent of the probe

hidden, and the freedom with which its end moves, the instrument is to be raised vertically and the head passed on along the internal side of the sac, inclined outward as much as possible so as to follow the tract of the nasal canal and glide gently through into the cavity of the nose. The manipulation must be delicately done. The probe is apt to get arrested in a follicle, or in a fold of the mucous membrane which it raises before it. It must then be withdrawn a little, and again passed forward with its direction somewhat altered. If after some trials we do not succeed in getting it clear of the obstruction, it is better to withdraw it, and repeat the attempt at a subsequent period, rather than run the risk of lacerating the lining membrane, which is usually found somewhat softened and thickened in these cases by the previous disease.

This method was devised exclusively by Anel for the purpose of freeing a passage for the injection downwards into the nose. It has also been employed for two other objects. First, as a preparatory step to the process of Mejean shortly to be noticed.

Secondly, for the purpose of dilating the strictured portion of the nasal duct, on the same principles that bougies are employed in the urethra. For this purpose the practice is warmly recommended by Mr. Travers, and Dr. Hays,* of this city. In my hands, it has seldom proved useful, and it is evident that the small size of the punctum must prevent the introduction of a probe of sufficient diameter to render the treatment efficacious. It has not, moreover, received the sanction of either Dr. Mackenzie or Mr. Lawrence.

2. *Catheterism of the nasal duct through the nostril.*

This is called the *method of Laforest*, from the surgeon who first put it into practice. It is applicable to various diseases of the nasal duct and lachrymal sac, and allows of the introduction of sounds and catheters of considerable size, without any previous opening made with the knife. It has latterly been much employed, especially by the French surgeons. The operation is one, however, which requires accurate knowledge of the structure of the parts, and considerable practice on the dead body.

Remarks.—The instrument employed first enters by the lower meatus of the nose, and penetrates from below upwards through the interior or nasal orifice of the nasal duct, and follows the course of the latter up to the lachrymal sac, so as to be felt at the internal canthus of the eye. In the adult the lower orifice of the nasal duct, which is under the inferior turbinated bone, will be found on the average at a point about two-thirds of an inch in a vertical line above the floor of the nostril, and about three-quarters behind the lower and lateral border of the anterior opening of the nose. The length of the nasal duct itself, which is rather less than half an inch, and the direction in which it runs, have been before described. Every instrument passed by this method from below upwards into the lachrymal sac, should penetrate through the anterior nares to the extent of nearly an inch and three-quarters, and have such a curvature as is calculated to turn the angle that the axis of the canal forms with the inferior meatus of the nose, which angle opens forwards, and is found to measure about 28 degrees.

* Vide Lawrence on the Eye, with additions, etc., by Dr. Hays. Lea & Blanchard. 1843.

Process of Laforest. (Pl. XLV. fig. 1.)—The instrument employed is a small silver tube or catheter, of which the exact size and shape are shown at figs. 1 and 6. A wooden handle introduced into the tube serves to direct it with more precision. The same hand may be used to introduce it on either side, but in general it will be found more convenient to employ the right hand for the left duct, and the left for the right,—a little practice rendering the manipulation with either hand perfectly easy. The patient is to be placed in a sitting posture, with his head thrown back and sustained by an assistant. 1. The surgeon then, seated in front, holding the instrument between the thumb and fore finger, rests the middle finger on the cheek bone, presents horizontally the point to the opening of the nostril, with the convex portion of the curve turned towards the septum, upon which he glides it back until the whole curved portion is entered; this curved portion should be exactly of the same length as the distance of the duct from the orifice, which, as has been observed, is about three-quarters of an inch. 2. He then turns gently upwards the handle of the instrument, describing an arc of about 40 degrees, passes it a little forward upon the pulp of the middle finger, so that it is placed exactly in a line between the eye of the operator and the middle of the superciliary ridge. By this movement the beak of the instrument is made to ascend from the floor of the meatus, under the turbinated bone, so as to present to the lower orifice of the duct—the convex portion resting by its middle on the maxillary border of the meatus. 3. If the point has entered the duct, which may be readily ascertained by attempting to slide it slightly backwards and forwards, the handle is to be gently lowered by rocking it over the thumb in the direction of a plane extended between the caruncula lachrymalis and the external margin of the first incisor tooth of the opposite side. If the point has fairly entered the duct, and this passage is free, it will have traversed its whole length, so as to be felt with the finger, and make the skin tense over the lachrymal sac at the lower and inner side of the caruncle, by the time the handle has been brought in front of the incisor tooth of the opposite side. The catheter having been thus introduced, Laforest injected fluids through it, securing it in its position by a thread passed through the ring at its free extremity; afterwards he substituted for it a flexible sound or catheter, which was passed through its cavity and left in the canal.

Process of Gensoul.—The instrument (Pl. XLV. fig. 6, b, c), employed by this surgeon is more easy of introduction than that of Laforest, and is the one which the author has found most convenient and useful. It is modeled on the form of the passage, and curved at an angle of about 100 degrees, so as to facilitate its introduction.

Special instruments are required for each nostril; each set consists of a curved sound for the opening of the passage, (Pl. XLV. fig. 6, b,) and a flexible catheter, (fig. 6, c,) through which passes a stilet, supporting a little *porte-caustique* at the end. The sound is graduated in order to show the depth to which it penetrates. This apparatus, devised for the purpose of applying caustic to the duct, answers equally well for injection and dilatation.

The instrument is to be held as a writing pen, and presented at first a little obliquely, with the beak of the horizontal portion supported upon the septum. By a quarter rotation of the handle, the extremity glides from behind forward over the septum and

the floor of the inferior meatus. By this movement the handle is placed nearly vertically downwards, but inclined a little so as to be in front of the inferior canine tooth of the same side, while the point is brought at the outer side of the meatus exactly under the orifice of the duct. Carrying the handle then in a direction upwards and outwards, so as to describe 80 degrees of the arc of a circle, the point, which has glided during this movement from below upwards on the external wall of the meatus, will be found at the orifice of the nasal duct. Then by a rocking or balancing

movement, which shall be at the same time from above downwards, from without inwards, and from before backwards, the handle is brought to a horizontal position, and in the direction of a plane extended between the caruncula lachrymalis of the same, and the first incisor tooth of the opposite side; and the point, which has moved in an inverse direction, will, if the duct be free, have entered the lachrymal sac. This process is very rapidly executed, and may be rendered very easy by a little practice. Other instruments have been employed for the cathe-

PLATE XLV—OPERATIONS UPON THE EYE.

LACHRYMAL PASSAGES.

Fig. 1.—*The usual position of the head in operations upon the eyes and through the nasal fossa is here shown.*

The patient is seated, with his head slightly inclined upwards and backwards, and secured by the hands (*a, b*) of an assistant standing behind him. The head of the patient should also be a little inclined to the side opposite to that on which the operation is to be performed. The instruments shown refer to the three principal operations performed on the ball of the eye and the lachrymal passages.

- c.* The cataract knife held ready to begin the puncture of the cornea in the operation for extracting the cataract.
- d.* Bistoury of Petit, applied in the direction proper for the puncture of the lachrymal sac and nasal duct in fistula lachrymalis.
- e.* The sound of Laforest introduced into the nasal duct through the nostril.

(*Fig. 2.*) PERFORATION OF THE INTEGUMENTS OVER THE LACHRYMAL SAC FROM WITHIN OUTWARDS, WITH THE TROCAR OF MANEC.

The canula in which the trocar is concealed has been introduced from the nasal fossa after the manner of Laforest. (*A, B.*) *Introduction of the tube or canula after the manner of Dupuytren.*

The bistoury has entered through the sac as shown in *fig. 1*, and is represented here as partly withdrawn and at the same time inclined forward and outward so as to widen the orifice and facilitate the introduction of the tube, which is seen descending into the passage on the mandrin or stilet as the knife is being withdrawn.

(*Fig. 3.*) INJECTION THROUGH THE INFERIOR LACHRYMAL PUNCTUM, WITH THE SYRINGE OF ANEL.

The surgeon depresses the lower lid with the fore finger of one hand, so as to render the punctum prominent while he insinuates the point of the syringe into its orifice, and makes the injection with the other.

(*Fig. 4.*) PERFORATION OF THE WALL OF THE ANTRUM MAXILLARE, WITH THE TROCAR OF M. LAUGIER.

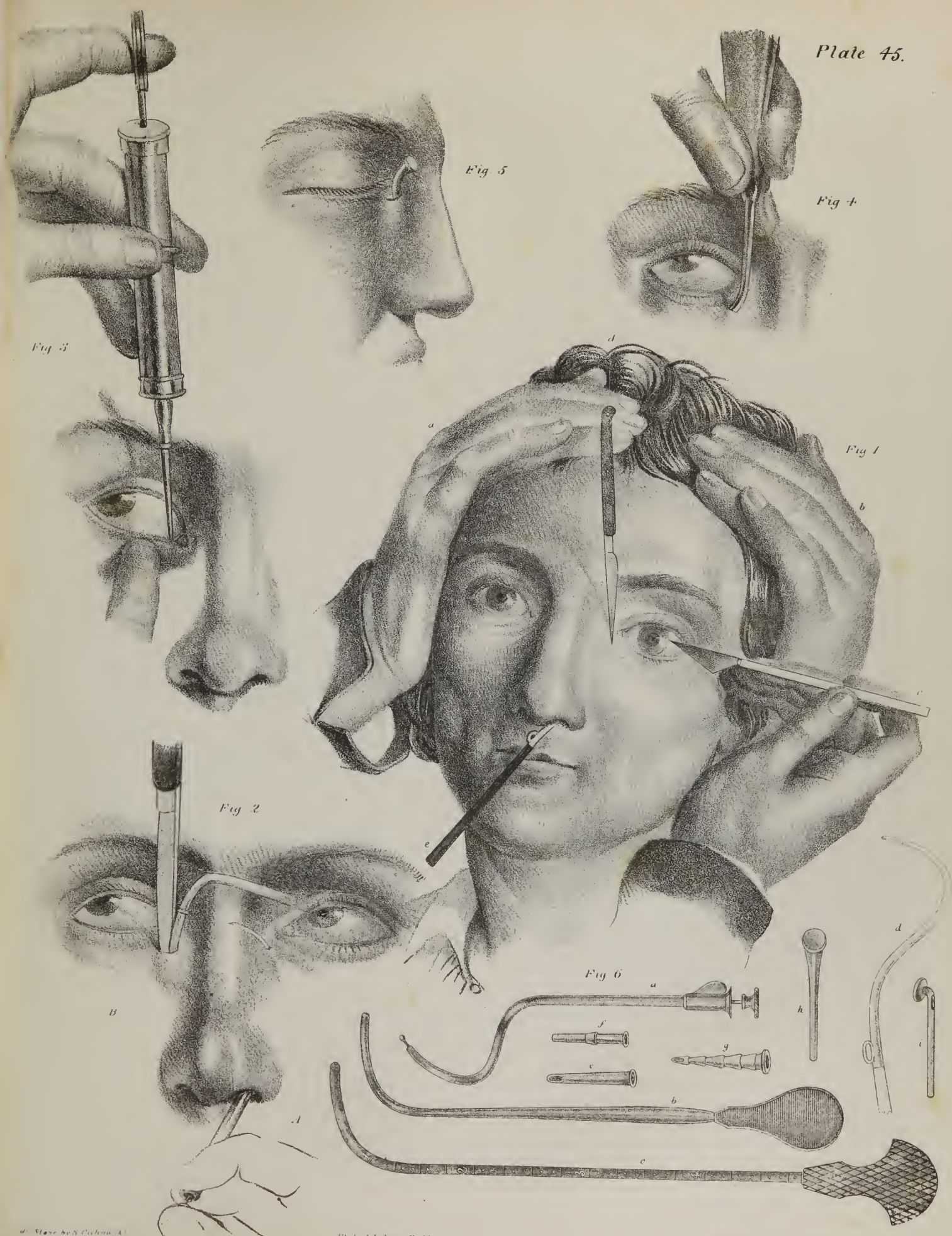
This operation is intended to make a new route for the tears, and can only be proper in cases of closure of the nasal duct by exostosis.

(*Fig. 5.*) INTRODUCTION OF THE NAIL-HEADED STILET.

The puncture of the sac has been made as shown in *figs. 1* and *2*, and the stilet has been partially introduced as the bistoury was withdrawn.

(*Fig. 6.*) INSTRUMENTS EMPLOYED IN THE TREATMENT OF OBSTRUCTIONS OF THE NASAL DUCT.

- a.* Silver catheter of M. Serres d'Uzes, with the proper curvatures for its introduction into the nasal duct from the left side of the nostril. It is introduced in nearly the same manner as that of Gensoul. A separate instrument is required for the two sides.
- b.* Sound of Gensoul—on account of its double curvature an instrument will be required for either side.



terism of this duct, by the process of Laforest, but they are merely modifications of the two already described. That of Serres d'Uses, a good instrument, more curved than that of Gensoul, is shown at Pl. XLV. fig. 6, *a*. To an instrument curved like that of Gensoul, Manec has added a little dart (Pl. XLV. fig. 2, *B*), for the purpose of penetrating the sac from within outwards, and to allow of the introduction of a mesh, with the object in view of effecting a gradual dilatation of the passage.

The repetition of the use of the sound of Gensoul or Laforest, for the purpose either of dilatation, employing injection, or the cautious application of lunar caustic, should be made at intervals of not less than three or four days, for fear of exciting too much irritation in the lining membrane of the nose and duct.

If none of the measures above alluded to succeed in removing the obstruction to the course of the tears, the inflammation of the lachrymal tumour may sooner or later be expected to terminate in ulceration and form proper fistula lachrymalis. When the opening of the tumour has taken place spontaneously, I have on several occasions, in subjects who were young and otherwise healthy, known the engorgement of the sac relieved by the suppuratory discharge, and the ulcer subsequently to cicatrize and leave the passages perfectly free without the aid of instrumental treatment. But so happy a termination is not commonly to be expected, and it is better, as a general rule, when the opening appears unavoidable, to discharge the pus by puncture with the knife, lest it should burrow and excite ulceration of the skin at a point not opposite to that of the sac, or involve the delicate bones in the vicinity. If the case has been of long standing, and there are great thickening and induration of the lining membrane of the duct, the restoration of the passage for the tears is not likely to be effected except by instrumental measures. These consist of *compression, dilatation, cauterization, and the formation of an artificial canal.*

Compression.—This is suited only to the lighter cases of disease, and when the inflammation has been so far reduced that pressure may be borne without pain. It is employed both for lachrymal tumour and lachrymal fistula. It may be made temporarily with the finger, for the purpose of evacuating the contents of the sac, or permanently with a little pad or graduated compress, secured by a bandage, or one of the instruments newly devised for compressing the arteries of the face. In itself compression is little to be relied on, as it acts only upon the lachrymal sac, but I have found it occasionally useful in conjunction with the employment of antiphlogistics and the injection of astringent fluids through the puncta or nasal duct.

Dilatation.—The object of this process is, by the introduction

of some foreign body, to effect a permanent compression of the thickened lining membrane of the nasal duct from within outwards, so as to remove its tumidity, and limit and restore the duct to its usual patulous condition. Concurrently with this measure, antiphlogistic remedies and different topical applications are to be employed in order to facilitate the cure. The various modes in which dilatation is employed, may be thus classed:—1. The introduction of some foreign body by the natural orifices—the puncta or the nasal duct,—a method which has also been occasionally employed for the cure of lachrymal tumour. 2. The introduction of some foreign body through an orifice in the anterior wall of the sac, which orifice is either kept open round the instrument, and the latter allowed to project above the skin; or the instrument is so pressed in that its upper extremity is lodged in the cavity of the sac, and the wound by which it was introduced closed above it.

1. *Dilatation by the natural orifices.*

By the upper lachrymal punctum. Method of Mejean.—This has been employed only in cases of lachrymal tumour, where, though there has been no fistulous opening of the sac, it was thought desirable to try permanent compression from within outwards,—as a sort of appendix to the treatment with the instrument of Anel. The delicate probe of Anel, (with an eye near the end armed with a silk thread,) is to be carried by the process for catheterism, described at page 182, from the punctum into the nose. The thread thus carried into the meatus, is to be seized and brought out through the anterior nares and tied to a small seton. The probe is then to be retracted, drawing out with it again through the punctum the thread, which now pulls after it the seton so as to lodge the latter in the nasal duct. To the lower end of the seton a thread is to be left attached, so that the surgeon may withdraw it at will, for the purpose of renewal or of augmenting its size. The thread of the upper end of the seton, which traverses the punctum, is secured upon the forehead with a piece of adhesive plaster, and left of sufficient length to admit of being drawn down for the purpose of renewing the seton from time to time.

This process is difficult of performance, and a variety of means have in former times been suggested to render it more easy. But it is scarcely necessary to enumerate them, as the permanent presence of the thread is found to excite so much irritation and ulceration of the punctum, that the process has been almost wholly laid aside.

Dilatation by the lower orifice of the nasal duct, called the process of Laforest.—This surgeon insinuated a solid sound, as far as the obstruction would permit, by the process already described,

c. Graduated flexible sound or catheter of Gensoul, enclosing a stilet which has a *porte-caustique* at the end for the cauterization of the passage, from below upward.

Both these instruments have a double curve as shown by the shading.

d. Sound of Laforest—the external orifice closed by the handle.

e. Tube or canula of Dupuytren.

f. Tube or canula of M. Malgaigne.

g. Canula of Gerdy. The last two instruments are devised as substitutes for the tube of Dupuytren, and from the irregularity of their surfaces, are less liable to become displaced.

h. Nail-headed leaden style of Scarpa.

at page 183. This he allowed to remain till it became movable by the retreat of the walls of the duct, resulting from the secretion excited by the presence of the sound. A hollow sound or catheter was then substituted for the former, introduced with a movable handle, and secured with a thread as before mentioned. Through this he also practised injections, upon the efficacy of which he mainly relied for the cure. *Vésigné* followed the same method, gradually augmenting the size of the instrument up to that of the natural dimensions of the passage. He employed a gum-elastic catheter, which was introduced on a curved stilet. Some difficulty will, however, be experienced frequently in the substitution of the larger instrument for the smaller, which *Malgaigne* has proposed to obviate by introducing a curved stilet into the one to be removed while yet in place, withdrawing the latter over it, and making it serve as a means of conducting the new one into the passage. The sound and catheter of *Gensoul* answer for this purpose better than the instrument of *Laforest*. But by this process, and all the various modifications of it which have been devised, the cure is slow, the necessary manipulation disagreeable to the patient, and relief by no means so certain as by the methods about to be described.

Dilatation through an orifice in the sac. (Pl. XLV. figs. 2 and 5.)—*Introduction of a foreign body from above downwards.*—If the sac has ulcerated spontaneously so as to leave a free route to the nasal duct, the dilating instrument may be passed at once from above downwards. But if the ulcerated opening of the skin does not correspond with that of the sac, or it is thought judicious to resort to this method of cure before the ulceration has taken place, the sac is to be opened by puncture in the following manner, which is but an improved modification of the plan of *Petit*.

The patient is to be seated in front of a good light, with his head supported against the chest of an assistant, who with one hand sustains his forehead, and with the other draws upon the external border of the orbit, so as to stretch the lids and render the round tendon of the orbicularis muscle prominent in front of the sac. The operator, seated in front of the patient, feels with the pulp of the index finger of one hand, below the obvious prominence of the orbicular tendon, for the ridge of the nasal process of the maxillary bone, which confronts the lachrymal sac. Resting his nail upon this, a small rhomboidal space will be observed between the nail and the tendon, and between the rising swell of the lower lid and the bone. If the parts be much swollen or painful, it may not be possible to feel the ridge of the nasal process, but it is not difficult to ascertain the position of the sac, which it must be recollected is to be opened below the orbicular tendon, and *seemingly the nearer to the nose the less sloping are the bony sides of the upper part of the nostril*. The want of knowledge of this apparent change of position of the sac, dependent upon the varying shapes of the nose, I have known the cause of considerable embarrassment in this simple operation. Through the centre of this rhomboidal space, guided by the nail of the finger resting on the ridge of the bone, the surgeon lowers the point of a bistoury (Pl. XLV. figs. 1, 2), held as a writing pen, with the back to the nose and the edge directed outwards and slightly downwards, so as to divide the space in the direction of its diagonal. The point is first to be passed from without inwards and from before backwards, as if we were about to strike the os un-

guis behind the sac. When it has pierced the wall in front and fairly entered the sac, the handle is to be raised, describing an arc of a circle from below upwards and from without inwards, till it comes in front of the internal end of the eyebrow, and in the direction of a line drawn from this point to the outer side of the ala of the nose. It now corresponds with the long axis of the sac and nasal duct, and is to be passed, lightly held, downwards without changing the double oblique direction of the blade and handle. The bistoury enters the orifice of the duct and is arrested by the edge and back coming in contact with its bony margin. It is not usually deemed necessary to enter it for more than half an inch, though the author prefers in all cases a knife narrower than the one represented in the plate, in order that it may pass freely into the duct, and divide any stricture that may exist within it. The common straight sharp-pointed bistoury of the pocket case, I find answers perfectly well for making the puncture. By following the process above described, the surgeon will freely open the sac, and avoid the chance of a result which I believe occasionally happens, viz., of the knife passing down on the anterior surface of the sac—the cavity of which is often considerably diminished by thickening of the lining membrane—thus rendering the introduction of the dilating body almost useless, as it would under such circumstances in all probability follow the knife and merely separate the membranous wall of the duct from the bone.

After the incision of the sac, the mode of proceeding is varied by different surgeons. *Petit* tilted the bistoury so as to make the wound gape; and, as he withdrew it, directed down along the channel near its back a grooved sound, which he passed through the duct into the nose to open the way, and finally substituted for it a small conical wax bougie, which was allowed to remain, and secured against sliding into the nostril by a thread fastened to its upper free extremity, attached upon the face by a strip of adhesive plaster. The bougie was renewed from time to time, and gradually increased in size, and when the duct had become restored to its natural diameter, removed altogether and the external wound allowed to close. This may still be considered an excellent method of treatment, and is advocated by some judicious practitioners of the present day.*

Some surgeons, after the artificial opening of the sac, have preferred the practice of *Mejean*, of introducing the dilating body, consisting of a seton or a piece of catgut, from below upwards through the nostril, with the exception that they first passed their conducting instruments, of which various kinds were contrived, from above downwards through the orifice in the sac. This method, though advocated by *Desault* and *Boyer*, is now, however, almost entirely abandoned, since it ill accomplishes the effects desired, and the manipulation through the nostril proves both tedious and painful.

Beer introduced catgut from above downwards, beginning with the size of the smaller strings of the violin, and ending, as the passage became more open, with the largest. The lower end was passed completely into the nose, and a few hours after, when it had become softened, it was blown or hooked out from the nostril and secured upon the cheek.

* Vide an article on the cure of fistula lachrymalis, by Dr. Parrish: *Philad. Med. Examiner* for July, 1843.

The introduction of a nail-headed style, (Pl. XLV. fig. 5,) after the manner of Scarpa and Warc, is the means employed most commonly by practitioners for effecting dilatation after the opening of the sac. The former surgeon employed a lead, the latter a silver style, about an inch and a quarter long and the twentieth of an inch in diameter. The style is to be introduced much in the same manner as the bougie of Petit, care being taken to push it at first from before backwards—especially if the common probe of the pocket case, which answers very well, has been used to clear the duct—so as to get the point well within the sac before the style is raised in the proper direction, to be carried down into the nose. In pressing down the probe to clear the way for the style, no force should be used, for fear of lacerating the os unguis or breaking into the antrum. If a probe of small size will not pass through, it should be entered as far as it will readily go under gentle pressure, and secured in its position by a strip of plaster to the forehead. In a day or two the opening may be thus enlarged by frequent trials till the probe or style will pass. The following judicious directions are given by Mr. Mackenzie for the management of the style, which is nearly after the manner of Ware.

“It is an instrument which generally may be worn for an unlimited time, not only without annoyance to the patient, but with a great degree of comfort. The probe being withdrawn, and a little tepid water injected, the style, previously passed through a bit of court plaster, is introduced from the sac into the duct, and pushed down so that the bit of plaster comes into contact with the integuments. The plaster serves to bring the edges of the incision as much together as the presence of the style will permit, and prevents the style from sinking into the wound. The wound closes gradually round the style, which is not to be entirely taken out for the first four or five days, but merely raised a little daily, so as to allow the parts to be cleaned. After the wound has healed so much that the opening closely embraces the style, this is to be taken out every morning, the nasal duct injected with tepid water, or some weak astringent solution, and then replaced. The aperture through the integuments into the sac soon becomes fistulous, having no disposition to close.

“During the time that the style is worn, the previous symptoms disappear almost completely. The style dilates the duct in the same way as a bougie dilates the urethra. The tears and mucus, absorbed by the lachrymal canals, appear to be attracted between the surface of the style and the lining membrane of the nasal duct, and thus the function of the parts being restored, the inflammation, watery eye, and the blennorrhœal discharge quickly subside.

“It frequently happens that a patient, after wearing a style for three or four months, has it removed, thinking the disease perfectly cured. After a time, however, the blennorrhœa returns, the style is re-introduced, and the symptoms again subside. After three or four months more, it again becomes a question whether the style should be removed. The patient often objects to its removal. He knows the inconvenience of the disease, and the little trouble of the remedy, and prefers continuing the use of the style, rather than run the risk of the blennorrhœa returning. I have known even ladies object to giving up the style, having once experienced a relapse from its removal.

“The style should be gold or silver gilt, to prevent it from becoming oxydized, and should have its head japanned of a skin colour, so that it may scarcely be observed, or blackened with sealing wax, so as to look like a little patch. The edges of its head should be rounded off, lest by pressure it cut the skin. It must on no account be left without regular removal and replacement. A patient in the lower ranks of life called upon me, with a silver style, which had been introduced by the late Dr. Monteath, and which had not been taken out for more than six months. It was all but corroded through, about a quarter of an inch below the head.

“In one instance, I witnessed profuse bleeding from the nostril during the day and night after pushing down a style. A short one had been worn, but not reaching the nostril, a longer one was introduced, and was followed by this effect.

“It is important to remark, that the style itself is occasionally a cause of irritation. It often is so, for some days after it is first introduced. We are obliged to apply an emollient poultice over the sac, or even to withdraw the style. Months after it has been introduced, and proved highly serviceable, we sometimes find that the patient complains of matter being still discharged by the side of the style. In such cases we should consider how far the style itself is a cause of this discharge; and if the Meibomian follicles, conjunctiva, and lachrymal passages, appear in every other respect sound, except only in the puro-mucous discharge by the side of the style, let it be gradually shortened, and at length removed, and a trial made whether everything will not, now that the passage is patent, go on as it ought to do.

“By shortening the style bit by bit, we try the state of the lower portion of the duct. If matters go on well with a short style, we may conclude that the passage is healthy, and think of removing it entirely; but if the disease returns under the use of the short style, we must re-introduce one of the original length. When we withdraw the style, with the intention of no longer replacing it, the edge of the opening through the integuments must be made raw; for if this is not done, it is apt to contract to an almost capillary fistula, very difficult to close. Sometimes, indeed, this minute callous opening may, in itself, furnish a palliative cure for chronic dacryocystitis. A lady consulted me, who had long been under the care of Dr. Monteath, for blennorrhœa and relaxation of the sac. She had worn a style for a length of time, but without a cure being effected. Dr. Monteath proposed laying open the sac and stuffing it, as is recommended in certain cases by Scarpa, but the patient declined this. The style was removed, the opening did not close, but continued patent for years; mucus continued to collect in the sac, and kept it greatly dilated; the eye was strong, and the patient thought nothing of the inconvenience of being obliged several times a day to press out the mucus through the callous orifice.”*

Mr. Liston, after the tube is worn for a short period, directs the style to be taken away entirely, the passage being kept clear by the occasional introduction of a probe or sound from the side of the nostril; or causes the patient to wear for some time, during the night, a very small style, which there will seldom be any

* A Practical Treatise on the Diseases of the Eye, by Wm. Mackenzie, M. D. London, 1840, p. 256-S.

difficulty of inserting through the minute and almost imperceptible fistulous aperture that remains in the front part of the sac.

Permanent dilatation with a tube, the wound cicatrized above it.

This is an old practice which was revived by Dupuytren, and has since been extensively employed. It consists in the introduction of a small gold or silver gilt tube into the canal through a puncture of the sac, which is allowed immediately to heal, as in the case of the wound after venesection. The tears find their way at once by the cavity of the tube, and the epiphora ceases. In the lapse of time—weeks, months, or even years, as it may be—the tube gets loose in the duct, which has become enlarged in consequence of its presence, and falls finally into the nasal fossa, from whence it is readily expelled. This may be the result in fortunate cases, but it by no means invariably follows. The tube may fall prematurely, and before the dilatation has been protracted for a sufficient length of time to remove the stricture of the duct, thus rendering it necessary to repeat the operation. Occasionally it has been found so loose as to rise up when the nose was blown, and become by its pressure against the top of the sac, a source of so much irritation, as to require to be cut down upon and removed. To obviate these inconveniences various modifications have been given to its form, rendering it more bulbous and irregular on its surface, so as to prevent its too easily sliding in either direction. Occasionally it happens that the very presence of the tube in an inflamed cavity like that of the sac under circumstances requiring the operation, has been a cause of so much irritation as to require its speedy removal. To obviate this necessity J. Cloquet and Malgaigne, after the puncture of the sac, dilate the passage for a few days with a mesh or sound, before the tube is introduced. The tube has been known many times to descend, so as to press by its lower end and excite ulceration through the palatine arch. It has in a few instances given rise to such inflammation as to produce a carious condition of the delicate bones about it. The tube itself is exceedingly liable to be choked up with mucus from the side of the sac, by calcareous concretions within its cavity, or by snuff on the side of the nostril, when the tears must find their way by its side, as in the case of the style; the good which it then effects accruing only from the dilatation, as in the case of the latter instrument.

The comparative merits of the two instruments have not yet perhaps been fully decided. With the tube the operation is rapid, but little painful, and at once finished. There is no deformity left, and though there is some risk of the contrary, it may be followed with no further trouble or inconvenience. The tube is not, however, suited to cases where there is much thickening or ulceration of the sac, as the parts will not, under these circumstances, close above it. With the style there is a mark for observation left upon the cheek, the cure may be less complete or followed even with a fistulous ulcer of the sac, but the operation is unattended with risk, and the instrument is always under the control of the surgeon—a circumstance which weighs strongly in its favour with the profession. Mr. Travers, who asserts that he has introduced the tube fifty times with excellent success, without having been required to remove it in more than two instances, nevertheless, for reasons analogous to the above, gives preference to the mode of cure by the style.

The process of Dupuytren for introducing the tube is as follows:—The instruments required are, 1. A tube (Pl. XLV. fig. 6, e), three quarters of an inch to an inch long, slightly curved, and tapering gently to its lower extremity, which should be beveled on the side corresponding with the concavity of the curve. At the top it should be furnished with a rim to lodge against the surface of the os unguis, a sixth of an inch in diameter, and diminish to about half the same dimensions at its lower end. 2. A mandrin or steel stilet for introducing it (fig. 2), with a handle joining it at an angle of 125 degrees; and 3. A narrow-bladed bistoury (fig. 2). The tube should in addition have a groove sunk along the inner side of the head for the purpose of affording a hold to a small hook or a bifurcated spring stilet, with a catch at each extremity, for the purpose of withdrawing it if such a measure should become necessary.

The sac having been punctured, as described at page 186, the tube, carried on the mandrin, is glided along the groove on the back of the bistoury into the upper orifice of the nasal duct. The bistoury is then gradually withdrawn, and the tube finally carried through the sac completely into the duct, upon the orifice of which the rim is to rest. Pressure is then to be made with the finger nail upon the lower part of the sac, so as to allow the mandrin to be withdrawn without raising the tube. If, on causing the patient now to blow through the nose, a few drops of blood appear in the nostril, or some blood mixed with air escapes from the wound, the operation has succeeded. If these signs do not appear, the instrument has made a false passage, or it is sunk too deep, or the curve does not hold the proper direction of the duct. In the first case the tube must be withdrawn and introduced anew. In the latter it will only require to be raised a little in the sac, and turned to its proper position. The operation being done, the wound is to be accurately closed with a piece of court plaster; the patient may resume his usual occupations, the course of the tears is re-established, and in a few hours all sensation of uneasiness at the angle usually subsides.

It may be mentioned here that Pouteau has proposed to open the lachrymal sac by an incision different from that of Petit, though the suggestion has not to any extent been carried into practice. His object was the avoidance of a scar upon the face, but the plan proposed incurs the risk of a still greater deformity in the internal canthus. He directs the internal canthus to be drawn inwards, and the lower lid depressed. The bistoury is then to be passed in between the caruncula lachrymalis and the border of the lid. By the plan of Petit no very obvious mark of deformity follows—unless the operator should be so ignorant or heedless as to divide with the bistoury the round tendon of the orbicularis muscle. This result has occurred in one instance within my knowledge, and was attended with singular deformity. The internal canthus being loosened in a great measure from its attachments, it was started a little outwards by the orbicular muscle, towards the middle of the orbit.

By cauterization.

This is a practice of ancient date, which has been latterly revived, in consequence of the advantages alleged to attend the treatment of strictures of the urethra by the same means. But the analogy between the cases of obstructions of the two organs

is only approximative, and the use of caustic for the cure of fistula lachrymalis has proved more often injurious than beneficial.

Cauterization has been employed from above downwards, after puncture of the sac—and from below upwards through the lower orifice of the nasal duct.

1. Cauterization after puncture.

Process of Harneng.—A small conducting tube is introduced into the nasal duct. Through this is passed down a heated stilet, or an instrument with a vertical groove, charged with argentum nitratum. The inflammatory symptoms which follow are to be treated as under ordinary circumstances; the process has commonly to be several times repeated. Caustic potash has in a similar manner been introduced, and very serious consequences have followed the rashness of the practice.

2. Cauterization from below upwards.

It has been done by M. Bermond, by attaching the thread of Mejean (see page 185) to a seton covered with a caustic paste. The only method of cauterization entitled to any credit as a means of cure, is the following, and by which it has been said considerable success has been obtained.

Process of Gensoul.—The instruments employed are those already described under the head of catheterism of the nasal duct (page 183). A *porte-caustique*, charged with the nitrate of silver, which is securely lodged in the little cup by being porphyzied over the flame of a candle, is introduced through the curved tube which has been previously passed into the duct, and applied to the seat of stricture. The operation requires to be frequently repeated, and may be aided by the occasional use of the sound as a dilating body, and by injections thrown up through the tube.

FORMATION OF AN ARTIFICIAL CANAL.

This was a method in common use with Celsus and the Arabian surgeons before the structure of the lachrymal passages was well understood. It is now employed only as a dernier resort in cases of absence of the nasal duct, or when it has been obliterated by a diseased condition of the bone, or by the effusion of lymph between the opposite surfaces of the duct.

A new canal has in some instances been spontaneously established by the ulceration of the os unguis, through which the lachrymal secretion passed readily into the nose. Three methods have been devised for the formation of the new passage. 1. By perforation of the os unguis. 2. By the maxillary sinus. 3. By the old route of the duct or at least in its direction.

1. *Through the os unguis.*—This is the process of the older surgeons, who made the opening through the bone with a heated iron, a trocar, or the end of a quill. The sac should be freely laid open in the *ordinary manner*, and to render the operation at all likely to succeed, it will be necessary, in order to prevent the subsequent closure of the new opening which is likely to happen, to remove a portion of this delicate bone, and introduce a gold tube, bulbous at its two extremities, which is to remain permanently, and over which the wound is to be immediately closed as in the process of Dupuytren. To remove the piece of

bone, Jno. Hunter recommended the use of a punch with a plate of horn or wood passed up through the nostril to serve as a point of resistance. But this method may be considered impracticable in consequence of the shape of the nasal fossa. The removal will be much better accomplished, and without fracture, by the ingenious instrument of M. Fabrizi, of Modena, for the perforation of the membrane of the tympanum.

2. *Through the maxillary bone.* *Process of Pécot and Laugier.* (Pl. XLV. fig. 4.)—The mandrin of Dupuytren, (fig. 2,) or a small trocar, similarly bent at an angle, is to be passed down upon the groove of the bistoury after the puncture of the sac. When the point has entered as far as it will into the duct, break through into the antrum by carrying the handle of the instrument upwards in the direction of the middle of the frontal suture, and enlarge the opening by movement with the point before its withdrawal. A tube is subsequently to be introduced. This operation has not, however, been employed intentionally on the living subject, and it is not known how the presence of the tears would be borne on the lining membrane of the maxillary sinus, or how great would be the risk of inflammation and caries.

In the direction of the natural duct. *Process of Wathen.*—An opening is to be made as much as possible in the direction of the duct, with a small drill, which is to be introduced through a puncture previously made in the sac. The gold tube of Dupuytren is then to be introduced and firmly fixed through the new made passage, and the wound immediately closed above it. This method, it is said, has been employed in one instance, with entire success by Dupuytren. In a case somewhat similar, M. Malgaigne succeeded in making a perforation in the direction of the natural passage by forcing down the steel mandrin of Dupuytren, for the introduction of the tube. The gold tube of Pellier, with an enlargement at each end, was inserted as usual to keep the passage open. From the little resistance encountered in making the new passage, it is very probable that in this case of Malgaigne, the occlusion of the duct was owing merely to the inflammatory adhesion of the inner surfaces of its lining membrane.

OBLITERATION OF THE LACHRYMAL PUNCTA AND CANALS.

This obliteration may be either congenital, or which is much more frequently the case, the result of long-continued inflammation of the margins of the lids. It is an affection exceedingly difficult to remove, and for which no method of treatment yet devised has given very satisfactory results.

1. The *imperforation* or *atresia* of the puncta, is usually congenital. A thin pellicle is found closing the orifices, the position of which is marked by a slight depression, the construction of the canals below usually being perfect. It suffices in these cases to pierce the pellicle with a needle after the manner of Hiester, and keep the orifice open for some time with a fine metallic thread, or slender piece of catgut. If any little fungous growths arise about the orifice, they are to be repressed by the application of astringent washes, or by being lightly touched with lunar caustic. When the obliteration is the result of chronic inflammation, or is occasioned by ulceration from the injudicious use of the instruments of Anel and Mejean, the same method is to be pursued, but the cure will be more uncertain.

2. *Obliteration of the lachrymal canals.*—This may likewise be either congenital or acquired. That which is acquired as a consequence of disease, occurs usually only in the passage of the lower lid. In a case of double obliteration, J. L. Petit is said to have completely restored the canal of the lower lid, that had been closed only at a few points, by the introduction of a fine gold thread, which was allowed to remain until it moved freely in the passage.

Where no remains of the canal can be discovered, it has been proposed to form a new passage from the border of the lid to the lachrymal sac.

Pellier made the perforation from without inwards, and relied upon the use of simple injections to keep it open. Monro proposed to open the sac and make the perforation from within outwards, a measure certainly not likely to be followed by much benefit. Malgaigne advises the use of the elastic dart stilet of Manec, (Pl. XLV. fig. 2, A,) which should be introduced through the catheter of Gensoul, into the cavity of the sac, and then passed forward so as to penetrate as nearly as possible in the natural direction of the canal, from the sac towards the free edge of the lid. The process of Pellier is perhaps of all the most rational. But none of these measures have been successful in my hands except where the obliteration has been slight. Besides the difficulty attending the first formation of the canal, it is scarcely probable that it would ever become endowed with the active absorbing function of the natural passage.

Operations to effect the obliteration of the puncta and sac.—In some obstinate cases of fistula lachrymalis, incurable by the ordinary means of treatment, it has been observed that the epiphora gradually ceased after a destructive inflammation of the sac, puncta and canals. This led the two Nanoni, father and son, to open the sac with the knife and obliterate its cavity. The one effected the obliteration with the actual cautery, the other with a mixture of alum and precipitate. This is a measure, however, which the surgeon should not lightly undertake, so great is the uncertainty of its being followed by atrophy of the gland.

Bosche recommends under such circumstances, the obliteration of the puncta by exciting ulceration at these orifices with a pointed stick of lunar caustic, a process which seems entitled to a preference over that above described. For if the sac remained of its full size, and should afterwards fill up with its secretions so as to form a mucocele, it might be laid open and dressed with stimulating substances like an ordinary cyst.

I had, two years since, under my care a young gentleman, in whom there was a congenital deficiency of the lower part of the sac and its nasal duct, whilst the puncta and lachrymal canals were perfect, and communicated together at the internal canthus of the eye. In this case, a style was, with some difficulty, inserted in the usual manner. It was worn during nine months, being frequently withdrawn, for the purpose of having the probe of Anel and injections passed in through the puncta, so as to keep open their communication with the new made route to the nose. By these means all the inconvenience arising from the epiphora, which had been troublesome from childhood, has been removed, except at times when the eye becomes suddenly exposed to the influence of a cold wind or is otherwise unduly excited.

In some instances, after the treatment of fistula lachrymalis with

the nail-headed style of Ware, considerable difficulty is encountered in effecting the closure of the fistulous orifice through the skin. If the use of caustic to the edges, compression and the application of a heated needle, should fail in effecting the cicatrization, it may be closed by excising its edges with the point of a small bistoury, and engrafting upon it after the manner of Dieffenbach, a piece of skin raised from the adjoining surface of the nose, but left attached at one point so as to keep up its supply of blood. The flap should be fastened with a few stitches, and cold applications kept assiduously applied for the first few days. The wound on the side of the nose should be allowed to close by granulation.

Ægylops or anchylops.—This is an abscess at the internal angle of the eye, immediately in front of the lachrymal sac, but without involving the apparatus for the transmission of tears. The ulcer which it occasions in its second stage, gives to the eye somewhat the appearance of that of the goat, from whence the disease has received its name. In its first stage it may readily be mistaken for lachrymal tumour; it requires, however, a very different mode of treatment. If the nature of the disease be not recognized, it may, in the end, not only excite ulceration of the skin, but also open backwards into the lachrymal sac so as to establish a fistula of that organ. In its early state, the ægylops may be readily distinguished; the seat of the disease is superficial, and accompanying it there are redness of the skin and congestion of the subcutaneous cellular tissue, whilst the flow of tears continues uninterruptedly along their proper channels. In this first stage, recourse must be had to local depletion by leeches, the use of emollients, and the employment of the antiphlogistic regimen. As soon as matter forms, it is to be evacuated; and if the practitioner be not called to the case till it has advanced to suppuration, the diagnosis will be rendered obscure in consequence of the collection of pus pressing upon the sac so as to prevent the passage of injections, or the introduction of the probe of Anel through its cavity. The character of the pus discharged by puncture will assist to disclose its seat—for if it does not come from the sac, it will be unmixed with mucus; and in general, it will be found that the sac, as soon as relieved from the compression, will admit the passage of the injected fluid from the puncta to the nostril. After the pus of the ægylops is discharged, the abscess is to be dressed with dry lint, touched, if its edges become fungated, from time to time with caustic, and the thin edges of the ulcer subjected to gentle but steady pressure, by the aid of a small graduated linen compress and a monocus bandage. The administration of tonics will also in general be required.

OPERATIONS FOR VARIOUS DISEASES OF THE EYELIDS.

These consist of Ectropion, Entropion, Trichiasis, Distichiasis, Blepharoptosis, Adhesion of the Lids, Tumours of the Lids, Coloboma Palpebræ, and Epicanthis.

ECTROPION.

In this affection the lid is drawn away from the eyeball, its lining membrane more or less everted, and the ciliary margin

Fig 3



Fig 6

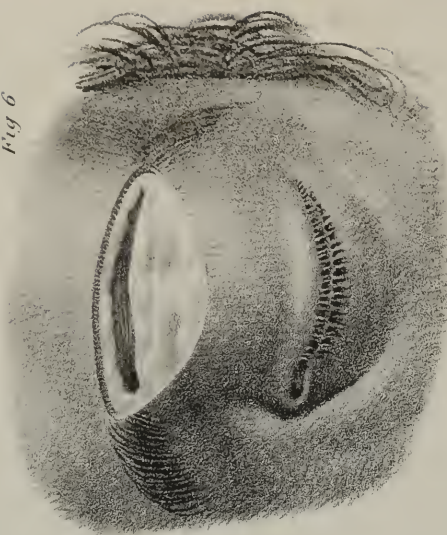


Fig 9

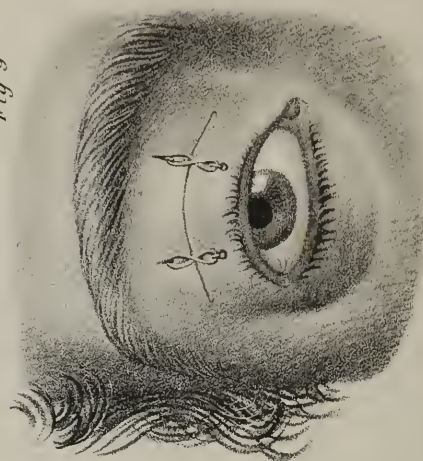


Fig 2

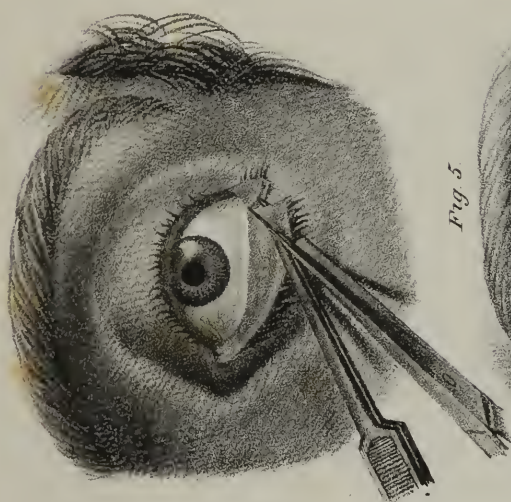


Fig 5

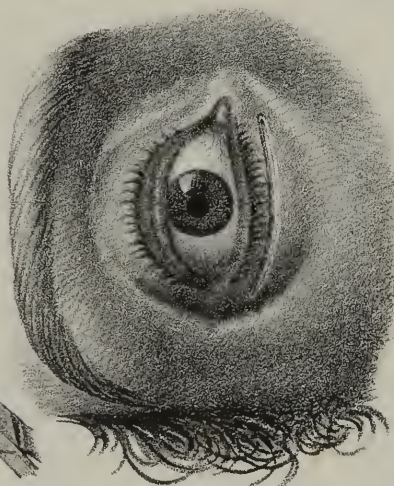


Fig 8

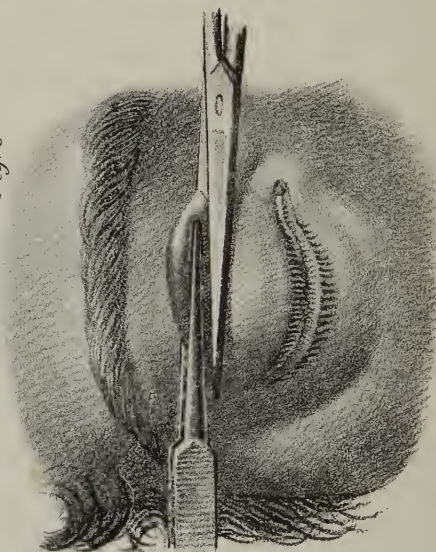


Fig 1

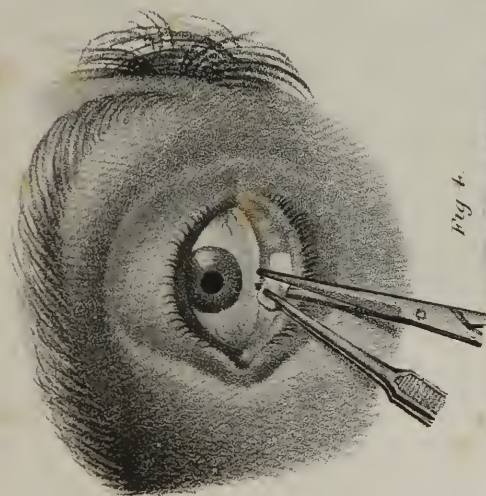


Fig 4

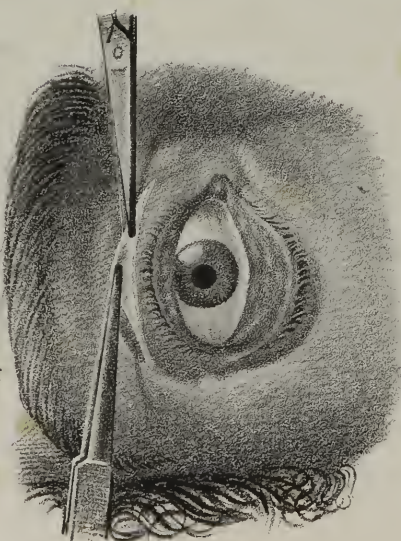
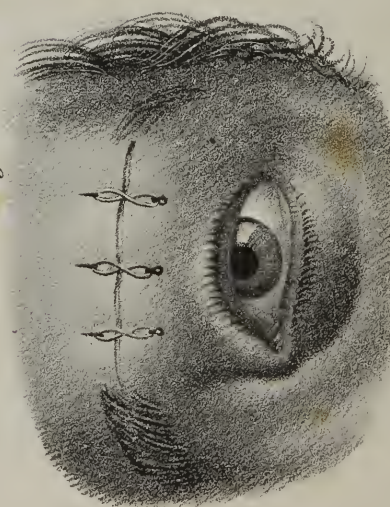


Fig 7



displaced upwards or downwards according as the seat of the deformity is in the upper or lower eyelid. In a great majority of cases it is, however, confined to the lower. When it involves the upper lid so as to keep the eye permanently open, it constitutes the disease which has been called lagophthalmia or oculus leporinus.

There are three principal varieties of ectropion. 1. One, and the only variety which may be considered acute, depends upon an inflammatory swelling of the conjunctival membrane which presses upon the lid so as to cause its eversion. 2. One, which depends upon the morbid contraction either of the lid itself or the surrounding integuments. This occurs frequently after burns or ulcers, the eversion then being produced either by the shortening of the skin or by a loss of its substance. 3. One, which depends upon caries or tumour of the margin of the orbit, by which the lid is pressed off from the eyeball and everted.

1. *Of ectropion caused by tumefaction of the conjunctiva.*—In its recent state this affection may usually be cured without any form of cutting operation, by resorting to the usual modes of treatment for conjunctival inflammation, conjoined, when the case proves more obstinate, with the use of lunar caustic or the mineral acids, so as to whiten for the moment the surface of the conjunctiva, and dispose it to contraction. But when the disease does not yield readily to these means, or the tumour is very considerable, or of long standing, one of the following operations is to be employed.

The *method* of operation is varied according as the seat of the alteration is confined to the conjunctiva—or when there is, in addition to this, as often occurs in the progress of the disease, a preternatural lateral elongation of the skin of the lid and the tarsal cartilage, so that if the lid were restored to its proper position it would not adjust itself accurately over the ball. For the first, a

PLATE XLVI.—OPERATION FOR ECTROPION AND BLEPHAROPTOSIS.

ECTROPION.

Fig. 1.—*Excision of the middle portion of the tarsal cartilage for the cure of ectropion of the lower lid. (Method of Weller.)*

Figs. 2, 3.—*Excision of a triangular or V shaped piece of the lower lid for the cure of the same affection. (Process of Dorsey and Sir W. Adams.)*

In *fig. 2* is represented the mode of removing the piece. A first incision has been made on the side next the outer canthus, and the forceps and scissors are seen applied for the purpose of making the second cut.

In *fig. 3*, the triangular wound left has been closed with the twisted suture, so as to turn the shortened lid inwards in its proper relation with the ball.

(*Figs. 4, 5.*) CURE OF DOUBLE ECTROPION. (*Process of Dieffenbach.*)

In *fig. 4*, an incision slightly curved has been made through the integuments of the upper lid down to the conjunctiva. The conjunctiva is shown drawn out through the wound for the purpose of having a portion of it removed with the scissors.

In *fig. 5*, a similar operation is represented as having been performed on the lower lid. The cut margins of the conjunctiva are to be attached to the lips of the cutaneous wound with harelip sutures. The lower lid is seen raised to its natural position by the shortening of its conjunctival lining.

BLEPHAROPTOSIS.

Figs. 6, 7.—*Removal of an elliptical portion of skin from over the superciliary ridge and the upper part of the eyelid. (Process of Hunt, of Manchester.)*

In *fig. 6*, the portion of integument is represented as removed with the knife, exposing the fatty layers below, and some of the muscular fibres over the superciliary ridge. In bad cases of blepharoptosis, I have found it necessary to remove a larger portion of the integument of the lid than is here shown in order to render the operation completely successful.

In *fig. 7*, the lips of the wound are seen united by three harelip sutures, which raise the upper lid and open the eye. The lower segment of skin gets an attachment after the cure to the muscular fibres over the orbit, so that the lid can subsequently be raised at will by the action of the occipito-frontalis muscle. The use of the common interrupted suture has appeared to me to be attended in these cases with less irritation than that of the harelip pins.

Figs. 8, 9.—*Excision of an elliptical portion of skin from the middle of the outer surface of the lid. (Ordinary process, suited to less extreme cases of blepharoptosis or palsy of the levator muscle of the lid.)*

In *fig. 8*, a longitudinal fold of skin is seen raised with a pair of forceps, so that it may be removed at one cut with the scissors.

In *fig. 9*, is represented the closure of the wound after the removal of the skin.

simple excision of a part of the thickened and sarcomatous conjunctival membrane will suffice—but in the case of the latter complication, it will often be necessary to excise also a portion of the substance of the lid, including the tarsal cartilage.

Excision of the conjunctiva.—This is, though an ancient, a simple process. The patient is to be seated with the head inclined backwards. The lid is to be depressed or elevated according as it is the lower or upper upon which we act. Then with a pair of good flat forceps, raise upon the middle of the conjunctival tumour a portion of it just sufficiently large to bring the cilia to their proper direction, and excise it by an elliptical cut with a pair of scissors curved on the flat, or a small scalpel, the sides of the ellipsis being left parallel with the free border of the lid, and the incision made from the external towards the inner canthus. The piece removed should be nearer the ball than the free edge of the lid. The subsequent treatment is to be the same as in ordinary acute ophthalmia—except that the bleeding from the wound will obviate the immediate necessity of local depletion. Benefit will often be derived after the bleeding has ceased by bringing the cilia towards the ball by a strip of adhesive plaster, and supporting the parts with a compress and monocular bandage.

Excision of a wedge-shaped piece of the lower lid. (*Process of Dorsey and Adams.* Pl. XLVI. figs. 2, 3.)—This is usually employed in addition to the excision of the conjunctiva; but in cases where the deformity arises merely from the lateral elongation of the lid, the operation in question alone is needed. This consists in the removal of a wedge-shaped piece comprising the whole thickness of the lid; the base of the piece corresponding to the free margin, and the apex descending a little below the inferior border of the tarsal cartilage. The breadth of the piece should be such as will reduce the margin of the lid to the proper length, and cause it when the wound is closed to rise up to its natural position. The excision should be made rather towards the external canthus than in the middle of the lid, in order to render the mark of the cicatrix less apparent, and interfere less with the movement of the organ. Having determined on the size of the piece to be removed, the surgeon lays hold of the lid with a pair of forceps, and draws it out from the ball. With a pair of strong straight scissors he cuts out the piece completely at two strokes—one on either side of the scissors—the two meeting below at an acute angle; or if he prefers, he may, in making the second cut, take a new hold of the lid, and apply the scissors on the outer side of the forceps. The lid is then to be restored to its proper position, and the edges of the wound united with two twisted or interrupted sutures. The first suture should be passed close to the ciliary margin, at the distance of about the tenth of an inch from the cut surface, in order to render the edge of the lid even. The other is to be introduced lower, and the lid supported with strips of adhesive plaster and a compress and bandage. The pins should be removed on the second day, lest they should cut out and produce lateral cicatrices.

Excision of the conjunctiva through the skin. (*Method of Diefenbach.* Pl. XLVI. figs. 4, 5.)—This may be applied upon either lid. The object of the process is to remove a portion of the conjunctiva, and attach the cut edges to the skin by a common cicatrix, so as to prevent its subsequent morbid elongation. It is done as follows:—The inverted lid being placed as much as pos-

sible in its natural position, the operator makes with a short straight bistoury, about a quarter of an inch from the ciliary margin, a semilunar incision of the skin, parallel with the edge of the lid, and occupying the middle two-thirds of its length. He next dissects the skin down a little towards the free edge of the lid, and divides the orbicularis muscle and the adjoining conjunctiva parallel with the orbital edge of the tarsal cartilage, to the same extent with the previous wound. Through this opening he seizes with a pair of forceps the cut edges of the palpebral conjunctiva and the tarsal cartilage which is adherent to it, and draws the conjunctiva out through the wound. The redundant portion of the mucous membrane is then excised above the level of the skin. The margin of the lid is at the same time turned in by the traction on the membrane, so as to have its proper relation with the ball. The wound is now to be closed with the twisted suture, the pins fastening together the two lips of the cutaneous incision and the included portion of conjunctiva, which is rendered raw by the previous incision. The pins are to be twisted outwards at their extremities, and cut off near the threads. They are to be removed between the third and sixth days, according to the judgment of the surgeon. After the cure a linear cicatrix only is left. This is an ingenious operation. It may, however, be observed that it is not in any way better calculated to remove the deformity than the simpler method above described.

Partial excision of the tarsal cartilage. (*Process of Weller.* Pl. XLVI. fig. 1.)—It has been observed that in old cases of ectropion, the tarsal cartilage is elongated with the other constituents of the lid. This surgeon, in order to bring it to its proper dimensions, after the excision of the hypertrophied conjunctiva, removed with the bistoury or scissors about a third of an inch of the middle part of the cartilage, so managing, however, as to leave at this point the palpebral margin of the tarsus entire, by splitting the cartilage near the edge. This operation resembles that known under the name of the process of Antylus. It leaves no cicatrix upon the surface of the lid, but is not on the whole deserving of so much reliance as the process of Dorsey and Adams already described.

We meet frequently with cases of excoriation and shrinking of the skin of the lid, accompanying and aiding in the first form of ectropion, which is kept up by the irritating secretion from the diseased membrane. This complication requires the same treatment as mentioned on the last page, with the addition of the application of the oxide of zinc ointment to protect the excoriated surface, and restore it to a more healthy condition. Cases of partial eversion are also occasionally met with in old subjects, the consequence either of palsy of the ciliaris muscle, or a relaxation of the palpebral ligaments that attach the tarsal cartilages to the two canthi, for which little can be done except by medical treatment.

2. Ectropion from shortening of the skin, the consequence of bad cicatrices.

This may effect, 1st, either lid singly according to the site of the cicatrix; or, 2d, it may effect both—especially if the injury be upon the temple near to or involving the outer canthus. In the variety of ectropion now under consideration, the eversion is generally very complete: sometimes when a single lid is affected, the ciliary

margin is found drawn downwards so as to be lost in the cheek, or upwards so as to occupy the position of the eyebrow. Ectropion of the upper lid, as will be obvious, leaves the eyeball more exposed than ectropion of the lower. If it be caused by a cicatrix on the side of the temple, the canthi may be drawn outwards, and one or both of the lids at the same time more or less everted.

Of the eversion of the free margin of the lids. Method of Chelius. A modification of the old operation of Celsus.—An incision is to be made through the skin along the whole breadth of the eyelid, and as near its tarsal edge as possible. The edges of the wound are to be dissected from the subjacent cellular tissue, so that all tension of the skin may be removed, and the eyelid brought into its natural position. The fibres of the orbicularis are then to be divided by several vertical incisions, and if the tumefaction of the conjunctiva be so great as to interfere with the replacement of the lid, a portion of it is to be snipped away with the scissors, and the external commissure of the eyelids slit up to the extent of some lines in a horizontal direction. Two loops of thread are then to be drawn through the skin near to the tarsal edge of the lid, and the ends secured with sticking plaster to the cheek or forehead according to the lid affected. By these means the eyelid will be kept in its proper relation with the ball. The wound of the eyelid and that of the canthus are to be covered with charpie, which is to be sustained in its position with strips of adhesive plaster. No other dressing is to be applied. This process is said by Professor Chelius, even in cases of very considerable shortening of the skin of the lid, to have been successful beyond expectation. If there is accompanying the deformity a considerable transverse elongation of the tarsus, the removal of a wedge-shaped portion in addition, after the plan of Dorsey, might be practised with advantage.

Process of T. Wharton Jones.—The peculiarity of this plan, according to its author, consists in the following particulars. "The eyelid is to be set free by incisions in such a way, that when brought back into its natural position the gap which is left may be closed by bringing its edges together by suture, and thus obtaining immediate union. The flap of skin embraced by the incisions is not separated from the subjacent bone; but advantage being taken of the looseness of the cellular tissue between the skin and the bone, the flap is pressed downwards, and thus the eyelid is set free. The success of the operation depends very much on the looseness of the cellular tissue. For some days before the operation, therefore, the skin should be moved up and down over the frontal bone, to render the tissue more yielding."

The operation was done as follows (on the upper eyelid). "Two converging incisions were made through the skin, from over the angles of the eye upwards to a point where they met, somewhat more than an inch from the adherent ciliary margin of the eyelid. By pressing down the triangular flap thus made, and cutting down all opposing bridles of cellular tissue, but without separating the flap from the subjacent parts, the eyelid was brought down nearly into its natural situation, by the mere stretching of the subjacent cellular tissue."* A piece of the everted conjunctiva is also to be snipped off, and in some instances it will be necessary to take away a piece of the tarsal cartilage, in order to bring the free edge of the lid in its proper relation with the ball. The edges of the

gap left by the drawing down of the flap are to be closed by suture, and the eyelid retained in its place by adhesive strips, compress, and bandage. This operation has been several times repeated, but with very variable results.

Sanson modified it by dissecting the long V shaped flap completely up to near its base. He then drew the lid at once to its proper position, united the two edges of the open fissure by suture, and left the flap loose, with the intention of removing at a later period all the redundant portion.

Method of Dieffenbach. Employed in eversion of the lower lid.—He includes the cicatrix in an incision of a triangular shape, and dissects it away—the base of the triangle being towards the ciliary margin of the lid, and concentric with it; the apex directed downwards. He then extends the line of incision which forms the base of the triangle, by another short incision at each end in the form of a crescent, and directed slightly downwards. Two lateral portions are thus marked out on the sides of the triangle, which are to be loosened a little by dissection, brought over towards each other, and secured together in the middle line by four or five small twisted sutures. As they come together they press up the remains of the lid, to the divided skin of which they are to be attached by their upper surfaces, thus being made to supply with new skin the place of the old cicatrix. This method by itself has not in my hands proved satisfactory. But in some bad cases of ectropion, I have found it highly useful conjoined with the excision of the wedge-shaped piece after the manner of Dorsey.*

Process of Horner.†—Professor Horner has succeeded in relieving a case of ectropion of the lower lid by the following operation:—the whole tarsus was permanently everted, the conjunctiva of the lid exposed nearly half an inch in breadth, and inflamed, ulcerated, and thickened. "An incision, two inches in length and down to the bone was made parallel with and at the inferior margin of the orbicularis muscle. The whole thickness of the eyelid was then dissected up from the adjoining bones. From about the middle of that incision started another, of an inch in length, downwards towards the angle of the jaw. From the termination of the latter another incision of the same length was directed towards the root of the nose. The last two incisions consequently defined an angle of integuments, which, being dissected up as far as its base, was then turned into the beginning of the first incision.

"An almost immediate correction of the deformity ensued. Common dressings were put on, and at the end of two weeks the cure was accomplished, with the exception that the margin of the lid was rather loose, but still leaving the prospect of that being corrected by a natural process of shortening in due time. The patient, in fact, was so far well, that he was discharged from the wards a week or two afterwards."

One or other of the above processes will answer in the major part of the cases of ectropion which occur from shortening of the integument; but if there be any feature in the deformity different from the usual cases of ectropion it must be met by some exercise of ingenuity on the part of the surgeon.

A few months since I had the son of a gentleman from Wood-

* Vide Amer. Journ. of Med. Sciences for 1842.

† Vide ditto, Nov., 1837, for a communication by W. E. Horner, M. D.

* Cyclopaedia of Practical Surgery, art. Ectropium. London, 1841.

bury under my care, in whom an extensive burn on the outer side of the cheek and temple had produced not only a bad case of ectropion of the lower lid, but had formed in addition two prominent, vertical, subcutaneous bands, tightly adherent to the skin, and riding over the external canthus. After taking out a large V shaped piece at the outer border of the everted lid, I passed a blunt pointed tenotome between the skin and the bridges, so as to divide the latter completely at two different points down to the bone. This allowed the skin to lay flat on the temple, and on the closure of the V shaped wound with pins, nearly every trace of the deformity was removed. The cure effected was permanent.

But in the more extensive cases of deformity, where the lid has been in a great measure destroyed, or it has been requisite to remove it on account of lupus or cancer, it is necessary to re-construct the lid by one of the plastic processes detailed in Part Fourth of this work. It may be well to observe, that whenever we can at the same time preserve the ciliary margin of the lid and lift it up to its place so as to form with it one line for the attachment of the flap, the result of the plastic operation will be rendered much more satisfactory. On the lower lid, the deformity will be found more readily removed than on the upper. For in regard to the upper, though the substituted lid may serve to cover and protect the ball, it cannot ordinarily be made to play upwards and downwards, as it will want the muscular structure necessary to the execution of these movements.

Eversion of the external commissure and the outer part of the lids, the consequence of a cicatrix in the region of the temple.—A different method of operation is required in this species of ectropion.

Tarsoraphy. Process of Walther.—This surgeon excised the tarsal edges of both eyelids including the commissure and a part of the neighbouring integument, in the form of a V shaped flap, the base of which was towards the eye and the apex toward the ear. The piece was about three-eighths of an inch broad at its base. The wound was closed with two harelip sutures.

In a case of extreme deformity of this kind, I practised with entire success the following modification of this process, suggested by Dieffenbach. After the removal of a large wedge-shaped piece, two semilunar incisions were carried from the cut edges of the lids—one upwards and inwards—and one downwards and inwards. The two crescentic flaps thus marked out were then raised, and after the closure of the wound in the temple, adapted as new lids to the remaining conjunctiva.

3. Ectropion from caries of the orbit and from tumours.

In eversion occasioned by carious ulceration of the margin of the orbit, no attempt is to be made to relieve the deformity by operation, until the cure of the bony structure has been effected. It will usually then be found necessary, in consequence of the destruction of the lid, to resort to one of the plastic processes for relief. Dr. Ammon has observed that considerable deformity is sometimes produced when but a small part of the skin is tucked in and rendered adherent to the bone. In such cases, without removing the little cicatrix, he circumscribes it by an elliptical wound and detaches the neighbouring integuments by dissection from the lines of incision so as to set the lid free, and allow it to

take its proper shape. The wound is then closed over the old cicatrix.

When ectropium depends upon the presence of a tumour within or below the lid, the removal of the tumour by extirpation or otherwise, is the obvious means of cure.

ENTROPION, OR INVERSION OF THE EYELID.

This affection involves most frequently the upper lid, is exactly the reverse of the one described under the name of ectropion, causes greater suffering than the latter, and is much more apt to be attended with an impairment of vision. The free margin of the lid is turned with its cilia inwards upon the eyeball, and from the friction the cilia exert upon it, keep it in a continual state of irritation. In trichiasis, the eyelashes alone are inverted upon the lid, without any morbid change of the tarsal cartilage; but in entropion, the cartilage is rolled inwards to a greater or less extent in the same direction with the hairs.

There are two principal forms of entropion—one depending upon a great relaxation of the skin of the eyelid, so that the skin, no longer reacting with the conjunctiva to hold the lid in its proper state of equilibrium, allows it to roll inwards when the mucous membrane suffers from chronic disease;—the second, upon a contracted and deformed state of the tarsal cartilage, the consequence more usually of ophthalmia tarsi or of protracted scrofulous or catarrhal conjunctivitis, without any preternatural laxity of the skin of the lid. In some cases the cartilage will be found rolled inwards at its free surface, almost into the form of a scroll.

Hence, there are two principal indications for operation,—to restore the margin of the lid to its proper direction,—or when this cannot be accomplished, which is but very rarely the case, to destroy the bulbs from which the eyelashes—the cause of irritation—grow.

1. Entropion from relaxation of the integument.

In the lighter and more recent forms of this affection, we may sometimes succeed in restoring the lid to its right direction by the use of strips of adhesive plaster, conjoined with the employment of such other local remedies as the state of the lids may indicate.

Use of adhesive straps.—The eyebrow having been shaved, three narrow strips of adhesive plaster are to be attached to the back of the upper lid near its tarsal margin. The lid is now to be raised and the other ends of the strips stuck upon the forehead in a divergent direction to maintain it in that position. Another strip of plaster, laid crosswise, secures the upper extremities of the three which raise the lid. The eye should be thus maintained artificially opened for the space of fifteen or twenty days, in order to give time for the establishment of a proper equilibrium between the skin and mucous membrane. The plasters will require to be reapplied every two or three days.

Excision of a portion of the integuments of the lid. (Pl. XLIX. fig. 1.)—This is a process very commonly practised and suited to the great majority of cases. The portion removed should be of an elliptical shape, and of such a breadth, that when the edges of the gap are brought together, the tarsus will assume its proper direction. The breadth of the piece necessary to be removed,

depends upon the state of the parts. In some instances, it is required to be an inch in breadth; but if a portion unnecessarily broad be taken away, ectropion might follow.

Seize between the thumb and middle finger of the left hand, or with a pair of proper ectropion forceps, a fold of skin parallel with the margin of the lid, *sufficiently large* when thus grasped to bring the lid to its natural position. Having carefully ascertained that the fold is of proper dimensions, the operator snips it away with a pair of strong scissors. One line of the incision should come close to the palpebral border, leaving, however, a strip for the passage of sutures. The edges of the wound are to be drawn together by two or three stitches. Langenbeck removes the sutures at the end of twelve hours; Weller, after eighteen hours. Much beyond this latter period, they should never be left, as they would then have a tendency to excite a phlegmonous œdema of the lids, which might lead to ulceration. For fear of such a result, Scarpa pursued the opposite extreme, and allowed the wound to close by granulation without suture. If the latter course were to be pursued, which the author would not however advise, the orbicular muscle should be kept depressed by the aid of a compress and bandage as directed by Malgaigne.

Dzondi has occasionally found it advantageous to add to this transverse excision, another made in a vertical direction. Janson, of Lyons, trusts to the excision of a vertical fold of skin alone, the broadest part of which should be near the palpebral margin.

By cauterization. Process of Quadri.—This is particularly applicable to slight and rather recent cases, where the skin is not very redundant. The object is to effect a contraction, or at most a slight ulceration of the surface of the skin. The escharotic most frequently employed is the concentrated sulphuric acid. But either of the mineral acids, or one of the solid forms of caustic, may be made to answer.

The lid is to be carefully cleansed. The eye is then to be closed. It has been advised to hold the lids closed by a narrow strip of adhesive plaster laid over their fissure, in order to prevent the introduction of any portion of the caustic between them. But with care on the part of the operator I have not found it necessary to use the strips. By means of a pencil of wood, a drop of the acid is to be rubbed over an oval portion of the integument, for an extent proportioned to the degree of inversion, and about a quarter of an inch in breadth at its middle. Care must be observed to keep the acid at the distance of at least the tenth of an inch from the edge of the lid. After a few seconds the eyelid is to be dried with a piece of lint, and the application of the acid repeated again and again, until a sufficient contraction of the skin is produced to restore the eyelid to its proper direction. The lid is then to be washed and dried, and the plaster removed. It may be necessary after a time to repeat the application of the acid. It has also been directed that the straightened cilia should be collected into little bundles, around which fine silk ligatures should be passed, and the ends fastened down upon the cheek, in order to retain the edge of the lid in its proper position. But this is a step not likely to be attended with much advantage.

2. Inversion from a contracted and deformed state of the cartilage.

In this variety of entropion, the tarsal cartilage is indurated and

shortened as well as turned inwards, and cannot by any degree of traction be brought back to its natural position. The margin of the lid is also in common thickened and uneven, and the cilia, which are few and dwarfish, are turned inwards directly on the ball, adding to the entropion that form of disease called trichiasis.

Simple section of the tarsal cartilage and lid. Process of Ware and Tyrrel.—As the transverse shortening of the tarsus is the principal cause of this deformity, Mr. Ware recommended the following operation for its relief, which Mr. Tyrrel states he has performed in many cases, including those of both lids, and in every instance with perfect success. The lid is to be drawn out from the ball and divided perpendicularly through its whole substance, either at its middle or at its temporal extremity; the middle, except in cases of partial entropion of the outer portion, being preferred. The section is immediately followed by a separation of the edges of the wound, forming a gap, shaped like the letter V. If the lid becomes immediately straight, nothing further is required, the wound is allowed to heal gradually by granulation, and very little deformity will result. If it should not become straight at the time, or should show subsequently a tendency to turn in, an oval portion of the integument may be removed in addition from the back of the lid, in the manner described above.

Double vertical section of the lid. (Process of Crampton modified by Guthrie. Pl. XLIX. fig. 3.)—One vertical incision is to be made with the bistoury or blunt-pointed scissors, through the whole substance of the lid, just at the outer side of the lachrymal punctum; and the other at about the same distance from the external canthus, in order—as regards the upper lid—to avoid the lachrymal gland. The incisions need not extend higher into the lid than necessary to divide the tarsal cartilage; the object of the operation being in a part to remove this from under the influence of the orbicular muscle. The loosened middle portion of the lid is now to be raised up; if it does not immediately become straight, it is to be nicked by a transverse incision on the side. A transverse fold of integument is then to be removed from the back of the piece, according to the usual process, and the edges of the incision drawn together by three silk ligatures. These are to be left long, and are drawn up—raising with them the middle loosened portion—and fastened to the forehead by two strips of adhesive plaster. To prevent union by first intention in the lines of incision, the piece is kept inverted by means of the threads for eight or ten days or until they cut out. The incisions are then allowed to heal slowly by granulation. During the time the lid is maintained in its elevated position, the ball must be protected with a fold of linen spread with cerate.

This operation is a serious one, from the apparent havoc which it makes with the lid. It has, however, been praised by Mr. Guthrie as successful.

Excision of the tarsal cartilage. (Process of Saunders. Pl. XLIX. fig. 1.)—Introduce between the lid and the ball a thin plate of horn or silver. Over this the lid is to be held tense with a pair of forceps. Divide then the integument and the orbicular muscle, just above the roots of the eyelashes, parallel with the margin of the lid, and down to the tarsal cartilage. Dissect up, so as to lay bare the orbital edge of the cartilage; detach it from the tendon of the levator palpebræ and the conjunctiva, and excise with the bistoury or scissors the part exposed, leaving only the

portion next to the palpebral margin, in which are lodged the bulbs of the cilia.

The object of this operation is to diminish the vertical diameter of the lid, by taking from it part of the structure which serves to keep it extended; the author of it believing that the levator would still continue its action, from its connection with the other membranes of the lid. The process, however, has usually followed by deformity, and it is now with great propriety laid aside.

The amputation of the edge of the lid, and the operations for the removal or destruction of the bulbs, belong properly to the subject of trichiasis, which so frequently complicates entropion; under that head they will be considered.

TRICHIASIS AND DISTICHIASIS.

Trichiasis has already been described as a vicious direction of the eyelashes inwards upon the ball of the eye, which may or may not be accompanied by an introversion of the free edge of the tarsal cartilage. It is an affection apparently of minor consequence; but is in reality exceedingly painful, troublesome, and persistent, and may even lead to loss of vision, by causing structural disease of the cornea.

Distichiasis is often congenital, and consists in the multiplication of the rows of cilia, which assume a vicious inclination on the ball. The accidental development of hair (pseudo-cilia) from some part of the mucous surface of the lids, may be considered as closely allied to the same affection. Whatever is the cause of the vicious direction of the hairs, and whether or not there is introversion of the border of the lid, the indication for removing them and preventing their reproduction is the same.

Extraction and cauterization.—Tear out the deviated cilia one by one by a steady pull with a pair of forceps square at the point, roughly ground or grooved on their adjoining surfaces, but without teeth. To find the smaller hairs, which are often colourless, a lens will be required. By a repetition of this measure from time to time, the bulbs may become at length atrophied, so as to cease to develop the hair. In general, however, it will be found more certain and satisfactory to proceed at once to cauterization after the extraction of the deformed cilia. For this purpose, the edge of the lid is to be everted, and a small plate of horn or metal introduced between it and the ball. Some apply at once the fine point of a stick of lunar caustic, or the end of a heated needle, to the orifices left by the extracted hairs. Neither can, however, be made to act upon the bulb, which is seated at a little distance from the orifice. It is better, therefore, to open the bulb at once with the point of a lancet or iris knife, and apply the caustic to its interior, so as to destroy the secreting surface. Dr. James Hunter has recommended the introduction of powdered tartarized antimony, which is to be collected on the moistened end of a darning needle and carried into the sac.

Extraction after incision. The lid having been raised on a thin plate as above mentioned, the operator makes two vertical incisions through the skin merely, a sixth of an inch in length, immediately above the free edge of the lid, so as to include between them the bulbs of the deformed cilia. The vertical cuts are to be united by a transverse incision near the edge of the lid, and the

little rectangular flap dissected and turned up, so as to expose the bulbs, which are to be torn away one by one with the forceps or excised with the scissors. In case of doubt as to their complete extirpation, the seat of the bulb may in addition be touched with caustic.

Amputation or excision of the tarsal margin. *Process of Schreger.*—Seize and reverse with the forceps the edge of the lid, and remove a semi-elliptical portion of the edge, so as to include the diseased parts, with a pair of curved scissors or a bistoury. The loss of substance should extend only to the cutaneous border, and not involve the cartilage.

M. Gerdy,* in bad cases of trichiasis with inversion of the lid, not remediable by the common treatment for entropion, has effected a complete cure in several instances by excising the whole margin of the lid affected. The excision is to be carried beyond the bulbs of the eyelashes; this will require the removal of a strip from the edge of the upper lid, about two lines in width, and one of about a line and a half from the lower.

In cases of *distichiasis*, the extraction merely of the pseudo-cilia will usually suffice, as there is less likelihood of their being reproduced.

BLEPHAROPTOSIS.

Ptosis, or falling of the eyelid.

This affection consists of the fall of the upper lid in front of the eye, as in a person asleep, without the ability of the patient to raise it. The loss of power may be congenital, owing to a defect in the structure of the levator muscle, or in the distribution of its nerve. It may be the consequence of palsy, forming the part of a more extended paralytic affection, or depend solely upon a considerable elongation of the skin of the lid, with a weakened power of contraction in the levator muscle. In the slighter cases, where it is dependent on chronic disease of the lid, we may succeed in removing it by the use of astringents, and such other topical applications as the case seems to indicate. If upon a relaxation of the integuments, the process of Quadri, or the excision of an elliptical piece of skin, as directed in page 195, may be resorted to. But if the ptosis be a congenital defect, or the consequence of palsy, the process of Hunt, of Manchester, is the only one that offers much chance of relief, and which has in my own practice proved highly satisfactory.†

Process of Hunt. (Pl. XLVI. figs. 6, 7.)—This process is ingenious. Its object is to attach the superciliary border of the occipito-frontalis muscle to the skin of the lid, so as to make it perform the office of the impaired levator. The eyebrow is to be shaved, and immediately below its site a curvilinear incision made, corresponding with the direction of the orbit, and of a length equal to that of the fissure between the lids. From the ends of this another incision is to be made, convex in the opposite direction—towards the free edge of the lid. The dimension of the piece of skin thus included must depend upon its state of relaxation, and will sometimes require to be more than an inch in breadth. The circumscribed integument must then be extirpated with the knife. I have occasionally removed it at a single cut

* Journal de Chirurgie Pratique, Oct. 1844.

† Vide Phil. Med. Examiner for 1844.

with the forceps and scissors, as in the common process for entropion. The edges of the divided skin are next to be drawn together with three twisted or interrupted sutures. The eye will be opened by this forced elevation of the lid; and after cicatrization, the edge of the occipito-frontalis muscle will be found to have contracted an indirect adhesion to the lid, so as to endow the patient with a voluntary power of raising it, while the orbicularis oculi retains its orifice of lowering it as under ordinary circumstances.

ADHESION OF THE LIDS. ANKYLOBLEPHARON. SYNBLEPHARON.

The adhesion of the lids together at the palpebral fissure constitutes the deformity known under the name of ankyloblepharon. Synblepharon consists in the adhesion of the lids to that surface of the ball which is usually free. Either of these may be congenital, the result of some excoriating disease, or of the ulceration following variola or burns. Both affections occasionally exist together. In ankyloblepharon, the union may be either direct or by the interposition of a thin membrane. It may be partial or complete. If the union is only partial, a small director may be passed beneath, and the adhesion divided with the knife or scissors. If complete, raise the eyelids so as to remove them from the ball, and make a puncture at the external commissure to allow the grooved director to pass, which should be bent to the form of the ball; on the director, the preternatural connection is to be divided with the knife. The lids should then be kept separate till the divided edges cicatrize, by raising the upper one with strips of adhesive plaster as described at page 194.

In synblepharon, the union between the palpebral and ocular surfaces of the conjunctiva must be separated by dissection with the knife. A renewal of the adhesion is to be prevented as far as possible, by the introduction of unguents, frequent motion of the lids, and the occasional use of the blunt end of a probe. The acute sensibility of the parts forbids the permanent interposition of any foreign body.

TUMOURS OF THE LIDS.

There are three descriptions of tumours commonly found in the lids, requiring operation. The *encysted*, (by far the most common,) the *cellular* and the *cancerous*. The first two are seated in the skin and subjacent cellular tissue. Occasionally, however, they are observed on the surface next the conjunctiva. The other most commonly affects the whole thickness of the lid inclusive of the conjunctiva.

Encysted tumours.—These are the natural follicles of the part, the cavity of which has been enlarged by disease, and distended by the accumulation of their secretions. The size to which they may attain varies from that of a large shot up to a hazel-nut. They are to be removed according to the side on which they are most prominent, either through the skin or conjunctiva.

1. *Excision by the skin.*—Make a transverse incision concentric with the wrinkles of the lid over the tumour, extending a little beyond it on either side, but without cutting into its cavity. Separate the circumference of the tumour with the point of the knife, raise it with the forceps or hook, and detach it from its

inner connections. The wound is to be united by first intention. I seldom fail in effectually obliterating these sacs when small without excision, by merely pushing the point of a small bistoury through their centre, and cutting afterwards from within outward so as to make a small opening in the skin; through this the contents of the sac are to be pressed out and the point of a caustic pencil or the end of a probe dipped in nitric acid, introduced to destroy the secreting surface.

When they are large, however, it is best to extirpate them. I recently removed one of the largest size from a patient of Professor Meigs, which had developed itself in the lower lid and sent up two processes, in the *furca* of which was lodged the tarsal cartilage; the processes were prominent on both surfaces of the lid, and rose considerably above its margin. The conjunctiva on its inner face presented a suspicious fungus-like aspect. An attempt to dissect it out might have involved the integrity of the tarsus and a portion of the conjunctiva. I therefore split it with the bistoury on its cutaneous surface, and detached the irregular-shaped sac from its bed with a couple of pair of forceps, and a few touches with the point of the knife. The cure took place with a cicatrix so small as to be scarcely obvious.

Excision by the conjunctiva.—Take hold of the ciliæ, and evert the lid over the finger, or the side of a large probe, in which position it is to be held by an assistant. Open the conjunctiva by a transverse incision, and proceed in other respects to dissect and remove the tumour as in the process above described. Tumours of a similar description, and requiring excision through the skin, are frequently found, especially in children, on the temple near the outer canthus of the eye.

Little tumours of a like character are occasionally developed on the *tarsal cartilage*, the result of disease of the Meibomian glands, forming small external swellings, often reddish coloured, on the lids. By everting the lid, the cartilage below will be found thinned and yellower than natural at the point opposite the tumour. It will suffice for the cure to make a puncture through the thinned cartilage into the interior of the sac, and irritate its cavity with the probe.

Cellular tumours.—*Chalasion.*—*Grando.*—Under this name are comprised little indurated masses seated near the edge of the lid, the result it is said of a hordeolum or sty, which has become hardened without running into free suppuration. They produce chronic irritation of the lids, and often form a small abscess which opens by a fistulous orifice through the conjunctiva, at one of the borders of the tarsal cartilage. They are very analogous to the class of tumours last described, and may be cured by a similar treatment. The plan of Carron du Villards is to dilate the fistulous orifice with the point of a knife, and carry on a small grooved director a little lunar caustic into the interior, so as to excite suppuration.

Cancerous tumours.—These if large will require the complete excision of the lid, and the immediate formation of a new one by a plastic process. Cancroid tubercles of limited dimensions occasionally form on the lid, and admit of extirpation without destruction of the organ. I have frequently succeeded in removing them by the application of caustics, and especially by the use of the two manageable forms known under the names of the arsenious, and the Vienna paste. In general, however, the acute sensibility

of the lid, and the risk of irritating the conjunctiva, render extirpation preferable. If the tumour involve only the skin and subcutaneous cellular tissue, it may be removed by a simple elliptical incision, cauterizing, in addition, if it be deemed necessary, the bleeding surface of the wound. If the tumour occupy the whole thickness of the lid without having much breadth, it can sometimes be completely removed by the excision of a V shaped piece of the lid, the base of which shall be towards the palpebral fissure; the divided parts of the lid being subsequently united by the twisted suture, as in the ordinary hare-lip operation.

COLOBOMA PALPEBRE.

This term, though usually limited to the fissure of the iris, has been applied to a gaping cleft through one of the lids, the result of an accident by which the lid has been divided through and the edges allowed to cicatrize separately, or consisting, as has in some few cases been observed, of a congenital defect. The operation required will be precisely the same as in hare-lip—the excision of the edges, and closure by the twisted suture.

EPICANTHIS.

This name has been given by Von Ammon to a congenital peculiarity, which consists in the extension of a crescentic fold of skin from the side of the nose over the internal canthus of the eye, existing when met with, commonly on both sides, and giving to the countenance somewhat of the expression belonging to the Calmuck. The operation performed by Dr. Ammon for the removal of these folds, consists in the excision of an elliptical piece of skin over the root of the nose, and bringing the edges of the wound together by suture. The folds, however, usually disappear as the child's nose increases in prominence. I have observed an analogous deformity accidentally produced, as a consequence of the loss of the nasal bone by syphilis and *ozæna*, and have succeeded in relieving it by a similar operation.

OPERATIONS PRACTISED THROUGH THE CONJUNCTIVA.

The diseases of this membrane, of which we shall treat, consist of different Fungous Excrescences, Pinguecula, Encanthis, Pannus, and Pterygium.

EXCRESCENCES.—ENCANTHIS.—PINGUECULA.

The *excrescences* of various kinds which form on the free surfaces of the ocular or palpebral conjunctiva, are to be laid hold of with the forceps and removed with the bistoury or scissors. As they have a strong tendency to re-development, the surface from which they are removed should be at once touched with blue stone or lunar caustic.

Encanthis is the name given to a tumour formed in the mucous and glandular structure of the caruncula lachrymalis. It may consist merely of a *simple hypertrophy* of the part, or it may be a *cyst*, or a *cancerous growth*. The proper mode of treating it is by excision, and this should be practised, if possible, without doing injury to the lachrymal passages.

The *pinguecula* is a little yellowish tumour developed over the sclerotic coat. Its nature is not well known. It seems from its colour to indicate the presence of fat, though it contains none. It is not subject to degeneration like the affections just mentioned; but if it becomes inconvenient or unsightly from its bulk, it may be removed by excision.

PTERYGIUM.

Pterygium consists in the development of a vascular and membranous growth in the subconjunctival mucous tissue. It is triangular in its shape, with its apex presenting towards the cornea, over which it has a tendency to grow, covering usually the insertion of one of the rectimuscles. In a hundred out of a hundred and five cases it was found by Ribéri* occupying the internal canthus. Its pathological structure is not thoroughly understood. It comes on insensibly and grows very slowly, existing sometimes for years without making any apparent advance—and seems confined to the middle and latter periods of life. It is connected loosely with the ball, but inseparably with the conjunctiva. It first appears under the guise of a few varicose vessels in the sclerotic conjunctiva, which it slightly elevates—the vessels being directed parallel with each other towards the centre of the cornea.

Pterygium has been usually described as consisting of three varieties, viz: 1. *Pterygium tenue*, which is thin, semi-transparent, and striated with blood-vessels. 2. *Pterygium crassum*, which from its redness, opacity, and consistence, presents the appearance of a thin muscle. 3. *Pterygium pingue*, which consists of the little masses apparently fatty, described above under the name of *pinguecula*; as this does not become red, and has no tendency to spread over the cornea and interfere with vision, it cannot properly be considered as belonging to the disease under consideration. The first and second varieties are evidently mere stages of the same affection, and require no specific difference of treatment.

As the pterygium, when its point reaches the cornea, becomes stationary, or advances so slow that its progress is almost imperceptible during a course of years, it does not require operation, except for the purpose of getting rid of the unsightliness which its presence produces. But when it threatens to advance rapidly over the cornea, or has already covered this structure so as to impair vision, its removal is more imperative. To effect this when it has resisted the use of the nitrate of silver, the wine of opium, and such other remedies as have been recommended, three processes have been employed—*excision*, *incision* and the *ligature*—the last two of which have now, however, gone out of use.

Excision. (Pl. XLIX. fig. 4.)—Place the patient as in the operation for cataract, and lay hold of the pterygium with a good pair of rat-toothed strabismus forceps, at the distance of a line or two from its corneal extremity. Raise it until the little cellular bands which attach it to the cornea are felt to give way, when it is to be excised from its point towards its base with the bistoury or scissors. However long the pterygium may be, the excision should not extend so far back as the point of reflection of the conjunctiva from the ball to the lid, lest adhesion should follow, so as to obstruct the movements of the eyeball. The base of the

* Elepharophthalamo-terapia Operativa, p. 110.

pterygium may be left under such circumstances, and will disappear under the suppuration which follows from the wound.

Scarpa's practice was indeed in all cases, to excise merely in the manner above described, the triangular point which covered the cornea, a little beyond the periphery of the latter, with the expectation that the remainder would shrink and disappear.

[Demours, after raising the pterygium, separated it from the sclerotica by passing in the lancet flatwise, detaching it first from over the cornea, and then dividing it across near its base.

Riberi pinches up the pterygium, divides it across near its base with the scissors, and then dissects it in the direction of the cornea with a fine scalpel.

If the portion of the pterygium covering the cornea be thin and transparent, it has been found sufficient to excise it up to the margin of the cornea; not detaching it above this latter structure for fear of weakening it so as to give rise to staphyloma, or producing interstitial inflammation; trusting after the extirpation of the base to the action of the absorbents for the removal of the adventitious layer left upon the cornea.

PANNUS.—VARICOSE CONDITION OF THE CONJUNCTIVA.—VASCULAR CORNEA OF THE ENGLISH SURGEONS.

Pannus consists in a state of general varicose dilatation of the vessels of the conjunctiva, with thickening of its tissue, and is the consequence of chronic inflammation of this membrane. It usually covers the whole anterior portion of the ball of the eye, including the cornea. It is found at various degrees of development, either as a thin vascular veil over the cornea, or a thick red layer obstructing vision. The vascular cornea of the English surgeons is nearly allied to the same disease, but differs from it in its primitive seat. It begins as an inflammation of the substance of the cornea in which the vessels become large and varicose, and subsequently spreads to the conjunctiva.

The treatment to be relied on in these affections at their early and middle stages is chiefly medical, in which may be included the free use of lunar caustic to the membrane, and various stimulating ointments.

Excision.—When a fasciculus of vessels is observed feeding the pannus with blood, advantage will occasionally be derived by removing with the forceps and scissors the middle portion of its tract. It has also been advised, when the cornea is thickly covered, to extirpate a circular fold round its base. But even after this operation, the central layer will be nourished from the vessels of the cornea. For this reason, Rognetta has advised the excision of the pannus from over the surface of this membrane, as well as over about a line of the corneal margin of the sclerotic coat.

But even after the performance of such operations, it is the medical treatment which is mainly to be relied on for effecting a cure.

OPERATIONS ON THE BALL OF THE EYE.

These consist of operations for Cataract, Artificial Pupil, Staphyloma, and Strabismus.

CATARACT.

The term cataract is used to designate that state of the eyeball in which an opaque body, situated between the iris and the vitreous humour, interrupts the entrance of light so as to impair or completely obstruct vision. This constitutes true cataract. The seat of the alteration is found either in the *lens* alone, forming *lenticular cataract*—in the *capsule* alone, forming *capsular cataract*; or involving at the same time both lens and capsule, constituting the *capsulo-lenticular cataract*.* These form the three generic divisions of this affection.

An effusion of opaque lymph in front of and in contact with the capsule, which has become organized like an ordinary false membrane without diseasing permanently the tissue upon which it is seated, is denominated *adventitious* or *spurious cataract*—a term which it is useful to retain, as a specific operation may sometimes be successfully practised for the removal of this adventitious body. The term of false or spurious cataract has, however, by many writers been very loosely and improperly applied to any accidental collection of pus, or blood, or lymph, within the anterior chamber.

Under the term of congenital cataract is included that form of true cataract which makes its appearance at birth or a few months after—a term of which it is also important to preserve the use, as the existence of the affection at this early period influences considerably the general principles of treatment.

Another division useful to retain in practice is that of *secondary cataract*, which consists in the opacity of some portion of the capsule, developed subsequently to an operation on the lens.

1. *Lenticular cataracts.*

These constitute the most common form of the disease, and as they vary greatly in their degree of consistence, have been divided into the *hard*, the *soft*, the *mixed*, and the *fluid*.

The *hard* cataract is met with in common only in advanced life—the lens is diminished in size, flat on its anterior surface, and convex behind. It is usually of a steel-gray colour, and has sometimes been observed of a yellowish-brown or black. The opacity begins in the centre, is slow, even years in attaining such a size as to destroy vision. There is a faint amber-coloured appearance of the lens common to old persons that interferes little or not at all with vision, which has been most unfortunately often mistaken for cataract, especially when it has been attended by an impaired state of vision from other causes. The hard cataract appears as if it had shrunk away from the iris, the margin of which, when the pupil is dilated, throws a shade upon it.

The *soft* or *caseous* cataract is large, and frequently comes in contact with the iris so as to bulge forwards its pupillary margin, and interfere with its play. There is then no shade thrown by the iris on the lens, but on the contrary the edge of the iris is a little everted so as to show in the form of a ring the black border of its pupillary orifice. These cataracts are usually of a milky, a light or a bluish-gray colour, often streaked or cloudy, and are found chiefly in early and middle life. When the cataract is swollen much above its natural size, it often gaps open in front,

* Many writers admit the liquor Morgagni as another seat of cataract, which they suppose to become opaque. But I believe there is no such fluid in the healthy state between the lens and its capsule.

forming three fissures, which pass from its central point to the circumference like rays. This variety is distinguished as the *dehiscent* or *gaping* cataract.

Mixed lenticular cataract.—This is denominated the *demi-hard*, or *demi-soft*, by Sichel, according to the degree of its consistence. The central nucleus is found round and hard, while the outer portion of the lens is of a tenacious, jelly-like consistence. The colour of this variety corresponds with the soft—its size is intermediate between the hard and the soft. It is difficult in many cases to distinguish this variety satisfactorily before the needle is brought in contact with the lens. In my own practice, I have several times observed the dehiscence to accompany this form of cataract.

Fluid cataract.—This is rarely if ever a primitive form of the disease, and appears to be the result of a loss of consistence in the structure of the soft cataract. Its colour is grayish, whitish, or yellowish, and the lens looks like a sac filled with thick gruel, cream or pus. The capsule will often be found bagged out a little at its lower border, and on shaking the head, little opaque particles may occasionally be seen floating through the fluid. Though the soft and liquid cataract is usually confined to persons below the middle period of life, including infants, and constituting the congenital form of the disease, it is nevertheless *occasionally* met with in advanced age.

2. *Of capsular or membranous cataract.*

This is found in individuals of all ages, and forms rapidly when the consequence of wound or inflammation. It is usually seated on the anterior half of the capsule which invests the lens. Here it is easily recognized, whether it involves, as is common, a part merely, or the whole face of the capsule. When partial only, it will form a whitish disk, if at the margin; a pearly spot, if in the centre; if it spread more generally over the lens, brilliant white striae, which appear under various forms, and have given it different appellations, as *arborescent*, *marbled*, etc. When it covers the whole surface, it has a glistening grayish aspect, and is usually marked with striae; if not distinguished by these marks, it is in general difficult to discriminate between it and the hard steel-coloured lenticular cataract. The opaque surface will, however, always be found more in contact with the iris than in cases of hard cataract. Opacity of the posterior half of the capsule is rarely met with as a separate affection. When the fluid lenticular cataract has been removed spontaneously by absorption, as is sometimes though rarely observed in childhood, or in consequence of an operation upon it in its soft or fluid state in which the capsule has been but imperfectly divided, the anterior and posterior portions of the capsule are liable to become opaque, thickened, shriveled, and adherent together, so as to constitute the secondary cataract, which will be found tough and parchment-like when touched with the instrument.

3. *Capsulo-lenticular cataract.*

Whenever the whole anterior surface of the capsule has become opaque, the lens behind it, according to the observations of Weller, will be found more or less in the same condition. In very many cases, the lens will also be found opaque when the capsule is but partially affected. This form of cataract is very common to all ages of life, and especially when the affection has been developed

as a consequence of inflammation of the membrane of the aqueous humour, or of disease of the iris. The texture of the lens may be found in any of the various conditions above described.

Remarks.

1. *Age of the patient.*—The operation for the removal of cataract may be performed successfully at any age; but as a general rule the restoration of vision will be found the more perfect the younger the subject. It has been proved by dissection that the place of the lens will be partially supplied by a central prominence of the vitreous humour, the amount of this fluid being after the destruction of the lens increased in bulk—a change which may be expected to take place more readily in young than old subjects. The operation has, however, many times been successful at the age of eighty—one instance of which has occurred in my own practice. In congenital cataract it is of the utmost importance that the operation should be done early, and at least within the second year. According to Middlemore, it should be practised between the sixth and eighth months; and Mr. Lawrence has operated so early as between the first and second. The principal reasons which render an early operation proper, are, the tendency of the capsule to become tough and flexible, either with or without absorption of the lens, so as to be not easily cut up; and that of the irregular action of the muscles to bring on a state of oscillation of the ball, which is not afterwards easily corrected, even when, by the destruction of the cataract, the entrance of light gives a fixed point for the direction of the eye. Saunders found the operation in cases of congenital cataract, at the age of fifteen, only partially successful.

2. *Season of the year.*—It was formerly the practice among surgeons to defer operations for cataract to the temperate periods of the year—spring and autumn. Any portion of the year, however, when the weather is fine, except at periods of extreme heat, is found equally to answer.

3. *Maturation of the cataract.*—The older surgeons dwelt much on the necessity of waiting for what is called the ripening or maturation of the cataract before proceeding to operate. By this they meant till it should become sufficiently hard to suffer couching or extraction without breaking up. But if we modify the meaning so as to understand a postponement till all inflammatory symptoms have subsided, when such have been the cause of the affection, or have been accidentally developed during its course, the injunction is still one of the highest moment. Every cataract, when it interrupts all useful vision, is in truth to be considered ripe and fitted for operation, unless there exists some specific counter-indication.

4. *As one or both eyes are affected.*—It has long been a rule among ophthalmologists, not to operate for cataract of one eye while vision remained perfect in the other, lest the latter should sympathetically suffer, so as to have its powers impaired; believing even if the operation should be most successful on the affected organ, that the two eyes would be left with unequal powers of refraction. This maxim is still to be considered the only proper general rule of conduct. But it must be recollected that it had its birth at a time when couching and extraction were the only methods of operation known—the safer and less perturbing manipulation with the needle for the cure by absorption, being of

later invention. We frequently meet with cases of single cataract in young persons of both sexes, in whom the removal of so conspicuous a deformity is strenuously desired, and where the operation is perfectly justifiable. In my own practice I prefer in such cases to operate early—as soon indeed as the cataract obstructs the sight and becomes a visible defect, as it will then in general be found less tough and resisting than at a later period, limiting myself to the method by absorption, the operation for which, in the hands of any one familiar with the structure, and skilled in the treatment of the diseases of the eye, should not be attended with suffering or danger. The inconvenience arising from the difference of refracting power is of but little moment, the best eye being the one that will be employed in vision, as in the cases in which this difference naturally exists;—or, if necessary, glasses of a suitable description could be worn, the use of which would even be preferred to the retention of the defect arising from the cataract. When, after complete cataract has existed in one eye, the symptoms of its appearance are manifested in the other, it has been recommended (J. Bell, Stevenson, Scarpa, Weller, Himly, Travers, etc.), to operate early upon the one already formed, not only for the purpose of getting rid of a positive defect, but of arresting the cataractous affection in the other. The author has operated several times under such circumstances, and in two instances with the result apparently of checking the progress of the affection in the better eye. But as such a result cannot with any positive certainty be relied on, the practice is not warrantable unless the state of the cataractous eye is such as to present the usual chances of success in the operation. When double cataract exists, it is a question yet undetermined whether it is better to operate on both eyes at the same sitting, or only one, deferring that of the other to a later period, when all the disturbance arising from the first shall have completely subsided. The latter plan is attended often with an inconvenient loss of time on the part of the patient, protracted anxiety, a double amount of seclusion and medical treatment, and exposes, at the operation upon the second eye, *at least to as great a degree*, that of the opposite side to the risk of sympathetic injury. It is, however, the practice advised by Physick, Dupuytren, Lawrence, and others, and becomes an obligatory rule when the operation is rendered more difficult and disturbing, from preternatural adhesions of the iris or the peculiar state of the ball, or when there is any infirmity of the constitution. Under other circumstances I follow the example of Beer, Sichel, Vidal, Mackenzie, and others, and operate on both organs at the same sitting, it being understood that the removal is effected by couching or the process by solution: double extraction, though practised usually by Roux, unquestionably exposing the eyes to greater risk of destruction by inflammation. By this plan I have had good success in both eyes, and with little if any additional pain or inflammation. The only instance within my recollection in which any sinister consequences have occurred in my practice at all attributable to the double operation, was that of an elderly gentleman of Salem, in North Carolina, who suffered on the following day with obstinate sickness and vomiting after I had couched both lenses. Such a result, however, often follows the couching of a single lens; and in this case the recovery was perfect and rapid in both eyes, and without any other untoward symptom. The propriety of the single or double operation must, however,

be determined in reference to individual cases as they come before the practitioner; but as a rule *applied generally*, it would be the part of prudence to act only on one eye at a time.

2. *Previous preparation.*—If the patient is in good health and of temperate habits, no previous preparation will be required, except rest, if he has taken a fatiguing journey, farther than moderate diet for a short time previously, and some cathartic medicine on the day before the operation. If there be derangement of the digestive organs, any inflammatory tendency, or any serious implication of the health, they must be removed by appropriate remedies. Mr. Middlemore recommended the insertion of an issue in one or both arms before operating by extraction on a gouty subject.

OPERATIONS FOR THE REMOVAL OF CATARACT.

These are of three kinds:—1. Those having for their object the *depression* of the cataract below the axis of the vision. 2. Those for its removal by solution and absorption. 3. Those for its *extraction*. No one of these operations can by any general rule be adapted for all cases, and it is requisite for the surgeon to render himself familiar with all, to be adequate to the thorough management of this affection. Each one, it will be shown, has its advantages and its objections; and the selection of the process made should depend on the nature of the case. The order in regard to frequency in which they are in this country employed, will be that of the second, first, and third, in the above classification. The success of this delicate operation, it must be remembered, will depend, more than in most other affections, on the dexterity with which it is accomplished, and the skill of the surgeon in preventing or subduing the inflammation of the organ.

1. *Of Depression, Couching, or Displacement, including Reversion and Reclination.*

There are three distinct varieties of this method, which differ from each other chiefly in regard to the place at which the instrument is introduced for the performance of the operation, viz: 1. Sclerotomy, or the posterior operation, in which the needle is inserted through the sclerotica near its anterior edge. 2. Keratomy, or the anterior operation, when it passes through the cornea; and 3. Hyalotomy, in which the puncture is made farther back through the sclerotic coat, and through the anterior portion of the vitreous humour. They are all commonly executed with a needle. This instrument has been extensively modified as to shape and dimensions, according to the will or caprice of different surgeons, so that more than seventy different varieties may be enumerated, of which however but a very few have received the sanction of general use. Those generally deemed most appropriate will be noticed in connection with each mode of operation. In each of the three methods of depression, the operation consists alike of four separate manœuvres. 1. The introduction of the needle. 2. The placing of its point between the lens and iris. 3. Its action on the lens and its capsule; and 4. Of its withdrawal from the eye.

Position.—The position of the patient and the operator in all operations for cataract is nearly the same. The patient may be seated on a low chair or music stool, while the operator, occupy

ing one somewhat higher, is placed directly in front, so that he may retain between his own the knees of the patient. One foot of the operator may, according to the direction of Scarpa, be rested on a stool so as to raise the knee, in order that it may serve as a rest to the elbow of the same side with the hand that holds the needle. This is the position recommended by the greater number of surgeons who operate much on the eye. It is the one which I have found most satisfactory, as it seems to leave the movements of the hand more free, and gives a better sense of the direction in which the lens is to be pressed. It is necessary, however, in

order to act on both eyes by this plan, that the surgeon should have practised with both hands on the dead body, so as to be completely ambidexter. Many surgeons, however, of great distinction, prefer the patient in all cases to be placed in the horizontal posture, with the head and shoulders elevated, shifting their own position so as to act with the right hand on the eye of either side. Others preserve the use of the right hand, by acting on the left eye in the sitting, and on the right eye in the recumbent posture, placing themselves for the latter purpose behind the head of the patient.

PLATE XLVII.—CATARACT. OPERATIONS BY DEPRESSION AND DIVISION.

DEPRESSION OR COUCHING.

Fig. 1.—Introduction of the needle.

The upper lid is raised by the fingers of an assistant, and the lower depressed by those of the surgeon. A slight pressure from the pulpy extremities of the fingers, serves at the same time to fix the ball. The needle of Scarpa, held as a writing pen, is presented in the direction of the lens, (*a, b*, fig. 5,) so that the curve near the point shall pass perpendicularly through the sclerotic coat as seen in the drawing. If a needle of a less curve than Scarpa's is used, and which is greatly preferred by the author, the direction of the handle should of course be more horizontal. The place of puncture, according to the author's views, is represented a little too far behind the cornea.

Fig. 2.—Division of the capsule.

The needle, with the convex surface of the curve in front, is seen gliding between the front surface of the capsule and the posterior face of the iris, in the direction of the line *c, d*, (fig. 5,) so as to get at the centre of the pupil, which has been previously dilated with belladonna. The point, which is turned toward the lens, now begins the section of the capsule.

Fig. 3.—The needle is here shown resting at the top of the lens in the direction of the line *e, f*, (fig. 5,) after it has completed the division of the capsule.

Figs. 4, 6.—Depression or couching of the cataract.

In fig. 6, the act of depression is shown at its commencement. The concavity of the curve of the needle rests on the top of the lens, the handle is slightly raised from its position seen in fig. 3, and the point is seen descending carrying the lens before it.

In fig. 4, the depression is seen completed, the handle has been raised to the direction of the line *g, h*, (fig. 5,) and the lens has been carried down out of view before the point, rendering the pupil clear.

Fig. 5.—Outline drawing, showing the changes of direction in the needle above mentioned.

Fig. 7.—Reclination or reversion of the lens.

After the introduction of the needle, and the division of the capsule as above described, the needle, with its curve resting on the anterior surface of the lens above its middle, is seen reversing the lens, so as to make its anterior surface present upward, and its inferior margin in front. By continuing the elevation of the hand, the lens will be couched in this position.

Fig. 8.—Side view of a vertical section of the eye, showing the same position of the needle in reclination as seen in fig. 7.

DIVISION AND SOLUTION.

Fig. 9.—Division.

The delicate, sharp-pointed needle, double-edged near the point, described in the text, is represented as seen in one of the operations of the author for soft cataract. The needle has been introduced somewhat nearer the anterior margin of the sclerotic coat than in the preceding operations for depression, in order that it may act better on the face of the lens. The same place of puncture as here shown, is also chosen by many surgeons in the operation for depression.

The surface of the lens has been freely divided with delicate strokes of the needle, and a few of the fragments pushed forwards into the anterior chamber. The fragments are represented lower in the anterior chamber than their actual position at the close of the operation, in order to leave the broken surface of the lens exposed to view.

Fig 1

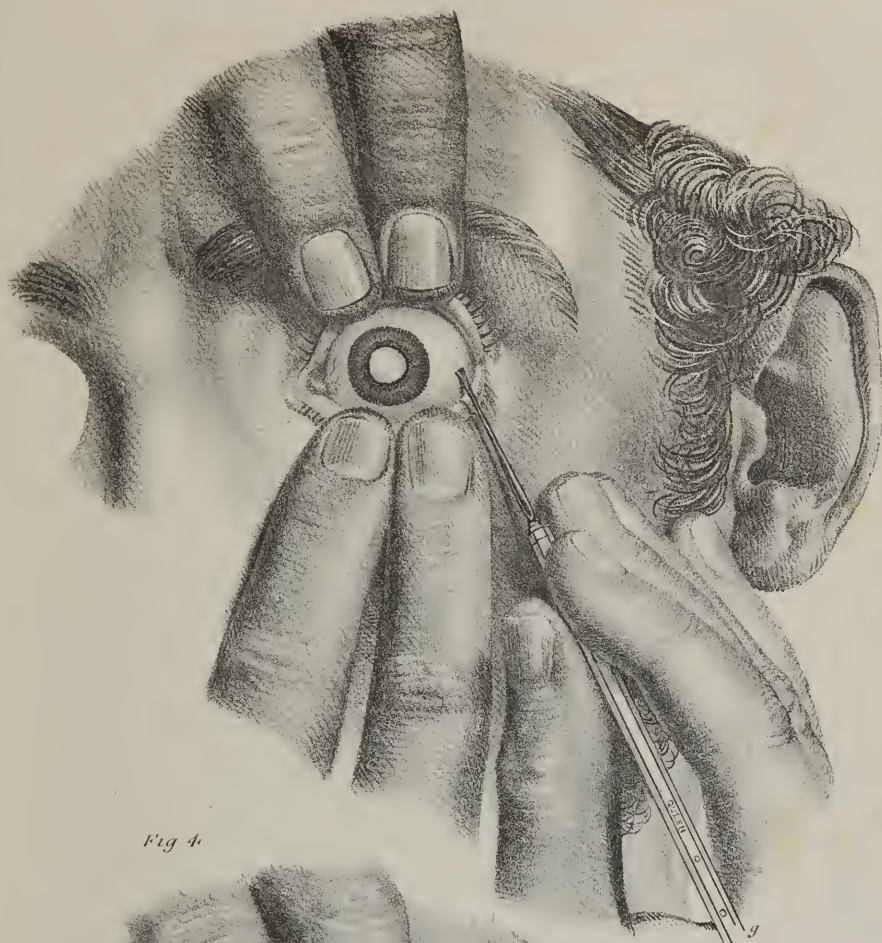


Fig 4

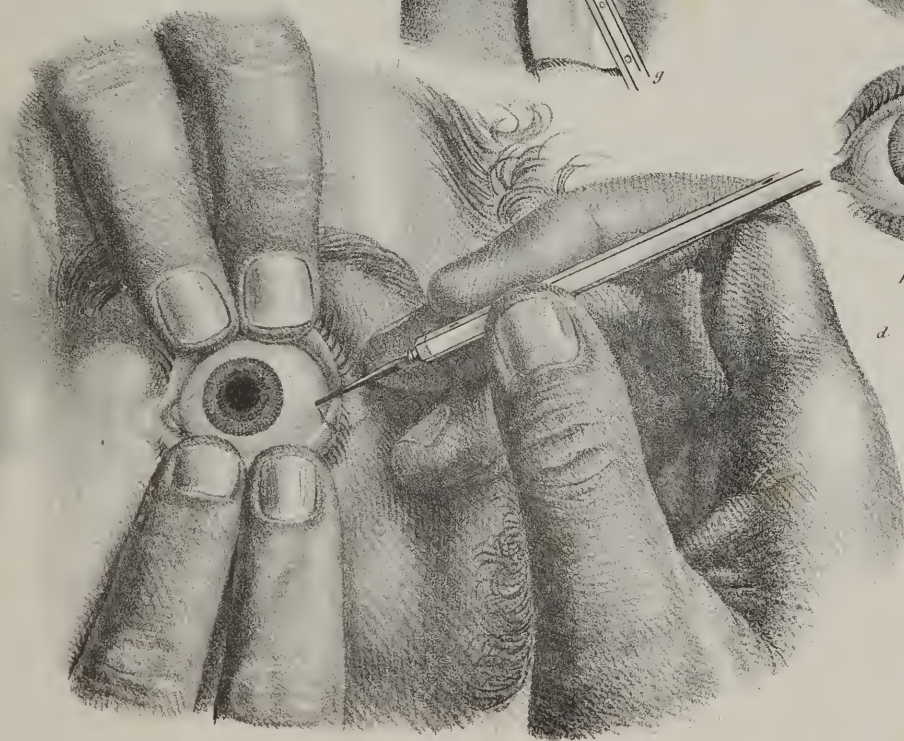


Fig 6



Fig 2

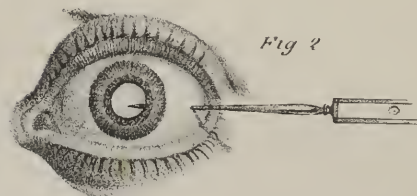


Fig 7



Fig 3



Fig 9

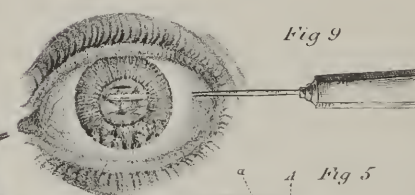
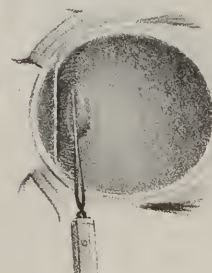


Fig 5



Fig 8



The *pupil* should be previously well dilated with belladonna, the extract having been smeared as a paste round the brow or temple, or a few drops of a strained solution of twenty grains of the extract to half an ounce of water, introduced between the lids some hours before the period of operation. The dilatation of the pupil will serve to diminish the risk of wounding the iris, and show more clearly the progress of the point of the needle.

Closing the other eye.—The eye of the opposite side should be closed with a compress and broad ribbon, or a handkerchief folded as a cravat, or with a few small strips of adhesive plaster above the lids in the manner of Professor Quadri, of Naples. Some, however, prefer to leave it uncovered altogether, as they believe by the patient directing it steadily forward, it may be made the means of keeping the one to be operated on more completely in the proper direction. In children and timid persons, it is much better, however, that the opposite eye should be closed, and especially if it be capable of vision.

Light.—The patient is to be so placed that the light will fall obliquely on the cornea; that of the north side of a room is to be preferred when it can be conveniently obtained, and the best way of admitting it is by a window, of which the lower half is closed.

Sclerotomyxis.—*Posterior operation.* (*Process usually employed.* Pl. XLVII.)—The instrument usually preferred in this posterior operation for the *couching* or *reclination* of the lens, is the lance-headed needle of Scarpa, curved at the point to the extent of about a fifth of an inch. It has been variously modified, the curve at the end for the purpose of embracing the lens being retained as the essential part of its construction. The shaft of Scarpa's instrument is made somewhat conical, in order to fill up the puncture in the sclerotica, and prevent the exit of any globules of vitreous humour from the cells divided in the operation. But the escape of a small portion of this humour from cells already lacerated, or even a somewhat larger amount, as might happen if the vitreous humour was unusually fluid, has been fairly proved to be a matter of little moment. In my own practice I give a decided preference to a needle of Scarpa's form, but of smaller dimensions, modified by taking away the crest on the concave surface of the curve, as in the manner of Dupuytren, perfectly sharp at the point and sides, and with a stalk slender and entirely cylindrical, as in the needle of Sichel. An instrument of this description will not become bound in the orifice of the rigid sclerotic coat, like one of a conical shaft. It admits of the point being freely moved in all directions without producing pressure upon the punctured sclerotic and choroid tunics; is sufficiently strong for all purposes, as no *force* whatever is to be employed, and is seldom followed by *any* discharge of the vitreous humour. The straight spear-pointed needle somewhat reduced in size, cutting on both edges near the point, is one also frequently employed, and answers an excellent purpose. It is occasionally even to be preferred, when on inspection of the lens through the cornea, the operator cannot be certain of its consistence—whether it will be found so soft as to admit of being cut up for the cure by solution, which can be rather more readily done with a straight than curved needle—or so hard as to require to be couched, which may be done with either.

The surgeon and patient are placed as above directed. An assistant sustains the head of the patient in a position a little

oblique upwards and backwards, and raises the upper lid with the two fore fingers of one hand, placing their pulpy extremities on the ciliary border, so as to be able at will, after the elevation of the lids, by a little downward pressure, to restrain the movement of the ball. But when the patient is indocile, or there is spasm of the lids, the assistant may instead employ an elevator or speculum to raise the lid. The surgeon, with the same fingers of one hand, depresses the lower lid in a similar manner; and with the other hand, in which the needle is held between the thumb and two first fingers like a writing pen, he gets a point of support by resting the little finger, slightly curved, on the cheek bone. The patient is now directed to look towards the nose; and it will be well to touch the front of the cornea with the curved back of the needle, in order to relieve the patient of the first sensation of fright at the contact of the instrument. The operator, holding the needle with the convex portion of the curve upwards, the cutting edges presenting front and back, directs the point upon the sclerotic coat, about the sixth of an inch behind the cornea, in the horizontal diameter of the ball, and with the handle of the instrument inclined downwards, so that the curved end shall enter perpendicularly (figs. 5, 6) at this point; the eye being at the same moment fixed by a little pressure with the fingers of the surgeon and assistant, which should act in unison. The puncture should be made with gentle but steady pressure, the needle being directed as if it were to go behind the lens, in order to avoid wounding the ciliary processes of the choroid, which lie a little in front of the place of entry.*

As soon as the curve has penetrated, the needle is to be rolled to the extent of a quarter of a circle between the thumb and finger, so as to present its convex portion forward, as indicated by the black spot placed for this purpose on the handle; and at the same time the handle is to be raised to the horizontal position without the little finger leaving its place of support. The handle is next to be inclined a little backward without advancing the point, when the iris, especially if the pupil do not remain well dilated, will be bulged slightly forward by the convex portion of the curve. The needle is now to be passed on between the iris and the anterior portion of the cataract till the point shows itself

* It has been directed by Mr. Tyrrel and others, to make the puncture the sixteenth of an inch only behind the cornea; but this will render the choroid processes more liable to injury, a result which is supposed to be the cause of the obstinate sickness and vomiting that are apt to follow depression. Scarpa, in making the puncture of the tunics, directs the needle to be held with the handle inclined to the temple, and the cutting edges vertical. In this position of the instrument, there is much greater risk of dividing the long ciliary nerve or artery, and we might as a consequence see the anterior chamber filled with blood during the operation. This, it is desirable to avoid, though when such an accident has occurred, the blood has usually been removed by absorption without injury following.

Much difference of opinion exists as to whether the puncture should be made in the equator of the eyeball or at a half line above or below it, in order to avoid more surely the ciliary vessels. The more common direction is to make it just below the equator. Mr. Mackenzie and Mr. Wharton Jones have deemed it important that it should be made in the equator. It has been well known since the publication of Zinn's plates of the eye, that the long ciliary artery divides into two forking branches at the distance of two and a half to three lines from the cornea. The question, therefore, may be thus solved: if the puncture be made near the cornea it may be made in the equator, though there is usually breadth sufficient between the forks to admit of the puncture half a line lower. At the distance of two and a half to three lines back, which is advised by some operators, the lower puncture is preferable.

in the pupil (fig. 2.) Then, by several slight movements with the point, the operator incises the capsule—first, at its internal semicircumference, then across its middle—with an ascending and descending cut in the shape of the letter A, finishing by a division of the external circumference of the membrane, so as to form the letter N; lowering the handle at this last step and raising the point so as to leave the concave part of the curve resting on the upper margin of the lens.* The handle is now to be lightly raised upwards, forwards and inwards, so as to stand at an angle of 45 degrees, without attempting to make any stress with the point. By this elevation of the handle merely, the point will descend, sinking the lens before it till both disappear behind the lower margin of the pupil; the lens being carried downwards and slightly backwards and outwards, so as to be lodged in the vitreous humour, (figs. 4, 6.) The lens is now couched, or displaced, and is to be held with the needle in this situation for twenty or thirty seconds to allow the vitreous humour to close around it and prevent its rising. The needle is then to be gently disengaged from the lens by slightly rolling it between the thumb and finger; the handle is next to be raised to the horizontal position. If the lens should be found to rise, it is to be depressed anew, (but without force, for fear of doing violence to the delicate retinal membrane,) and held for a little longer period in that position. The needle is now to be withdrawn, reversing the position in which it was entered—the convex portion being turned first towards the iris—then so as to present upwards—and the handle depressed as the curve leaves the sclerotic coat. The operation, though long in the description, is quickly performed. It must, however, be done without the least haste or nervousness. As the lens descends, the pupil becomes clear, and if the retina be in a healthy condition, vision is instantaneously restored. The eye is not, however, to be immediately used. It should be carefully covered, or, which is better, the patient confined to a dark room. The diet must be restricted, and belladonna extract freely applied around the temple and orbit, to keep the pupil dilated and prevent any adventitious adhesions. If retinal or iritic inflammation follow, the antiphlogistic treatment must be freely carried out combined with the internal administration of calomel and opium.

Remarks.—1. Some operators neglect altogether the previous division of the capsule. If it should be couched along with the lens, an occurrence which is not to be relied on, all might be well, though it would diminish greatly the chance of the subsequent absorption of the lens. If it should be left without being well broken up, it is exceedingly prone to become opaque and form a secondary membranous cataract, more difficult to get rid of than the primitive affection. Others follow the directions of Scarpa, first couching the lens, and then bringing the needle back so as to break away the capsule behind the pupil. But when the capsule is transparent, it cannot be well seen after the lens has been displaced and the point of the needle is liable by doing injury to the neighbouring parts, to increase the subsequent irritation. When cut up, as in the process described, the capsule, though

it does not in general become absorbed, rolls up towards its outer margin and shrinks away so as to be of no future inconvenience.

2. If the cataract should prove of the fluid kind, its liquid contents will escape on the first incision of the capsule into the anterior chamber; if the capsule should not be wholly obscured, it may still be further divided before the instrument is withdrawn—but if it should be hidden by the turbid humour, no movements of the point should be made at random, for fear of wounding the iris—it being much better to resort to a future operation for its removal if any should be needed. In several instances, however, of this description, I have found a perfect cure to follow a single semicircular cut upon the capsule. The posterior part of the capsule is so thin and delicate, that it is not apt to give rise to any inconvenience, unless uselessly lacerated with the needle, and it need not, except it be opaque, be interfered with. If the cataractous lens should be hard at the centre and soft at the circumference, I have several times found it advantageous to cut up the anterior soft portion, push the fragments gently into the anterior chamber, and couch the central nucleus. If it should prove altogether friable, the attempt at depression should be abandoned, and the cure trusted to the ordinary process by division and solution.

In passing the needle between the iris and lens, great care must be observed, in sweeping the curve forwards, not to spit or transfix the latter, which might be prematurely unseated should this happen. At all events it would serve to embarrass the movement of the instrument, unless the accident was discovered, and the needle slightly retracted and correctly passed. This transfixion is not likely to occur unless the cataract is large, so as to render the space for the passage of the needle unusually narrow, and when such is the case the ciliary processes are likewise much more liable to be injured. In this state of the parts, which may be determined by careful inspection beforehand, *when I use the curved needle with the expectation of couching*, I adopt the precaution in passing the curve forwards recommended by Mackenzie and others, that is, to raise or lower the handle so as to gain room by letting the point sweep over a more distant portion of the circumference of the lens. When the right hand is used I find it more convenient to raise the handle and carry the point below—when the left, to depress it and carry the point of the needle above. To avoid this transfixion, Mr. Mackenzie directs the needle to be passed to the centre of the posterior surface of the lens, and as the depth to which the instrument penetrates cannot be seen, he has the proper distance for insertion marked by a groove upon the needle. Then raising it to the top of the lens he divides vertically the *posterior* part of the capsule, and proceeds to act on the anterior,* by carrying the instrument underneath the lens to its front surface. But the directions for the division of the posterior part of the capsule appear to me less judicious than those given in most other instances by this experienced practitioner.

3. In case the lens should be dislodged and escape through the pupil, the operator may, in imitation of the practice of Dupuytren and Lusardi, follow it with the needle, replace and couch it, or, which is generally to be preferred, especially if the lens has been found hard, and therefore more likely after couching to irritate the

* With the cylindrical needle, which moves freely in the sclerotic wound, I find it much more simple and easy to follow the practice of Sichel;—make a few slight horizontal incisions with a sawing motion, and cross them once or twice in the opposite direction. With the conical shaft of the ordinary needle, it is better to follow the direction in the text.

retina, to leave it for the moment in the interior chamber; then allowing a little time to elapse, so that the pupil may contract, and thus diminish the probability of escape of the vitreous humour, cut down upon it through the cornea as in extraction, and remove it by a small opening.

4. If the cataract be of the capsulo-lenticular kind, the capsule cannot readily be cut up with the needle without doing some violence to the eye, and it is better then to couch both it and the lens in one mass together. Under these circumstances it will be necessary to retain the cataract a few seconds longer than usual, and disengage the needle from it with much caution. For it is in these cases that the cataract is particularly prone to rise after couching, in consequence of its still retaining unbroken some shreds of its old means of attachment.

5. If any adhesions exist between the posterior surface of the iris and the capsule, the margin of the pupil will be deformed by the attempt to couch. If the adhesions do not readily give way, it will be necessary to divide them cautiously with the edge of the needle before depressing the lens, for fear that the traction which they would make on the iris might detach it at its outer margin.

6. *Reclination.* (Pl. XLVII. fig. 7.)—This is effected by pressure with the needle on the top part of the lens, so as to reverse it, making its anterior surface present directly upwards, and then proceeding to couch it flatwise below the lower edge of the pupil. It is difficult, however, to prevent its re-ascent without doing extensive injury to the vitreous humour. This mode of couching is, therefore, but seldom practised. It may, however, be found of useful application, when the lens continues to rise after depression by the usual method. For if it should, after being reclined, afterwards float up in the axis of vision, its narrow edge will present forwards, allowing the rays of light to pass by on its upper surface. In attempting to reverse the lens, however, it will sometimes be found to revolve on its axis; in such instances the lens should be merely depressed in the usual manner.

Keratonyxis.—*Anterior operation.*—*Depression and reclination through the cornea.*—It is quite easy to effect the reclination and partial displacement of the lens by a needle introduced through the cornea; the complete depression or couching of the lens is accomplished with more difficulty, and is apt to be accompanied by injurious pressure with the instrument upon the lower border of the iris. The wound of the cornea left, has also been frequently followed with opacity. The operation of depression can, therefore, in almost all instances, be more safely and successfully accomplished by puncture through the sclerotic coat. The anterior operation has, however, been advised in cases where the eye is small, deeply sunken, and unsteady. A needle curved near the point like that of Scarpa, but more delicate in its structure, will in general be found best suited to this operation. Langenbeck, Walther, and other German surgeons, employ one with a greater curve. Sichel gives the preference to a needle of which the head is bent at an angle with the shaft.

The needle, with its point presented perpendicularly, is to be introduced through the lower part of the cornea at the distance of about a line from its margin, the concave side turned upwards and the convex downwards. It is then to be pushed onward to the cataract through the pupil, which should be previously dilated.

After lacerating the capsule, the hollow part of the curve of the needle is to be rested on the top of the lens, somewhat to the inner side of the middle line. By raising the handle the lens is then carried downwards and outwards, and imbedded in the vitreous humour. In this position it should be held for a few seconds before the needle is withdrawn. The operation may also be accomplished by puncture either at the upper or outer portion of the cornea, and in case there be any existing opacity, it will be better to select that as the point for the introduction of the needle.

*Hyalonyxis**—or *puncture through the vitreous humour.*—This process differs but little from that of scleronyxis, except in the introduction of the needle, which is passed either through the sclerotic coat at the distance of two lines and a half behind the cornea—or at the usual place, giving the instrument in the latter case a more backward direction, so that it may be carried through the vitreous humour in a way to avoid all chance of wounding the iris or choroid processes, and be made to act upon the back part of the cataract, somewhat as in the operation of Mr. Mackenzie described in the preceding page. It has been praised by a traveling English oculist of the name of *Bowen*, as a successful method of couching secondary or membranous cataract, which may by this process be lodged so deeply in the vitreous humour as to prevent its tendency to re-ascent—a difficulty encountered in its displacement by the ordinary operation through the anterior margin of the sclerotic coat. Travers also accorded to it a decided preference in the operation for congenital cataract. Bretonneau and others have likewise employed it as a means of couching in lenticular cataract, making with the needle a previous downward incision of the hyaloid tissue, in which they lodged the lens in order to keep it from contact with the iris and choroid coat, and effectually prevent its rising. If the needle be entered far back, it necessitates, however, a puncture of the anterior end of the retina, which cannot be wholly free from the risk of evil consequences. The method has not been much employed, and scarcely deserves its peculiar name. The edge of the vitreous humour is nearly always punctured in the ordinary posterior operation, or scleronyxis, which for that reason has likewise by some been denominated *hyalonyxis*, so as to lead to confusion in terms.

Second method.

Removal of cataract by its division into fragments, which subsequently disappear either by solution in the aqueous humour, or by absorption.—This is of all others the mode of operation most frequently practised; the one which inflicts the least injury upon the eye, it being sometimes unattended with the slightest irritation; may be safely repeated from time to time if it be necessary, and is on the whole to be considered the most successful. To cases of hard cataract, or long-standing capsular, whether primary or secondary, it is not however suited; but in ordinary congenital cataract, in that of young persons following injury, and in all the great majority of cases in which the cataract is soft or fluid, it is decidedly the most appropriate. It is not, however, always the one most immediately satisfactory to the patient, who is anxious at once to experience the benefit of the operation. The period at

* From *hualos*—glass (the vitreous humour being so termed from its transparent appearance), and *nusso*—I pierce.

which the cure is obtained must depend much on the state of the lens. If this be fluid, it may be perfect in the course of a week. If it be consistent and gelatinous, several weeks or months even may elapse before vision is restored, though it may be perfect in the end. It is not necessary, however, in these protracted cases, to wait the result of a single operation, as the process of division when properly performed may if necessary be several times repeated, and almost with impunity, at intervals of two, three, or four weeks. It has even been observed that a sort of tolerance of the eye to succeeding operations becomes established, provided these are not repeated until all irritation following a previous one has disappeared. The younger the subject the more rapid in general will the process of solution be found to go on.

The object of the operation is to open freely the anterior part of the capsule and expose the lens to the action of the aqueous humour, the lens being itself divided into fragments, or, in the language of Sir C. Bell, *puddled* or converted into a paste. If it be of such a consistence as to break into fragments, these are to be passed with the needle through the pupil into the anterior chamber, where the process of solution will be more readily effected. The operation may be performed either by the introduction of a needle, as by the anterior operation, through the cornea—or by the posterior, through the sclerotic coat.

The *posterior operation* is the one most generally preferred, as better admitting the free division of the lens and the dislodgement of the fragments. It exposes the iris quite as little to injury, and is not liable to be attended by the opacity of the cornea and the inflammation of the membrane of aqueous humour that sometimes follows the puncture through the cornea. In either operation the pupil must be previously well dilated with belladonna, stramonium, or hyoscyamus. If the curved needle is used for the posterior operation, it is to be *introduced* in front of the lens, precisely in all respects as directed at page 203. The subsequent manipulation is different; instead of attempting to couch or recline the lens, we merely, after lacerating the capsule, divide it into fragments by several horizontal and some vertical or oblique movements of the point, pushing at the conclusion the fragments a little forward with the curve of the needle.

In common with many other practitioners, I decidedly prefer for this operation a slender, straight needle, flattened and lancet-shaped near the point, and with a sharp cutting edge extending back on each side for the sixth of an inch. This must be introduced with the flat corresponding with the antero-posterior diameter of the eye, and in a direction as if it were to be passed to the centre of the ball. As soon as the cutting edge has penetrated the tunics, the handle should be rolled between the thumb and finger so as to present the flat surface of the needle forward, and the point which should be directed between the iris and lens, passed on till it nearly reaches the opposite side of the pupil. One of the cutting edges is then to be turned upon the cataract for the purpose of dividing it. This should be done by retracting the needle a little, pressing its cutting edge at the same time against the opaque mass—again pushing forward the needle, and again retracting it in the same manner, but in a different direction, until the whole cataract is divided into small portions, which are to be passed with the needle through the pupil into the anterior chamber. This is an operation peculiarly well

suited to the lenticular cataract of infants, and seldom in such cases, when thoroughly performed, requires repetition. The needle is to be retained, however, but for a very brief period in the eye; and if the pupil does not remain well dilated, or the aqueous humour becomes opaque so as to mask the movement of the needle, the surgeon should content himself with doing less, recollecting that if the capsule only be freely divided, so as to let in the aqueous humour upon the lens, the latter sooner or later becomes dissolved; and that it is much better to repeat the operation at a subsequent period, than to incur the risk of injuring either the iris or ciliary processes.

In *operating upon an infant*, several assistants will be required. The arms should be bound to the side by a piece of muslin pinned around the chest, or by a pillow-case drawn over from the feet upwards, and tightened round the neck. The child thus secured should be laid upon its back on a pillow; one assistant, taking hold of the arms, confines the upper part of the trunk—and another embraces with his hands the side of the head and face, so as to keep it in the right position. The upper lid is to be raised with a speculum by a third assistant, or by the surgeon himself, if in operating he wishes to employ the right hand for the right eye, when he is to seat himself behind the child, and rest its head against his breast.

Keratonyxis, or anterior operation.—This process is seldom resorted to for the cure by solution, save in those exceptional cases referred to on the preceding page.

The needle should be small and delicate, and the shank, of a diameter just sufficient to fill the puncture of the cornea and prevent the escape of the aqueous humour. The straight or curved needle may be used, but the latter will be found the most efficient form. Mr. Jacobs, of Dublin, employs for this operation the common sewing needle, of the size known in the shops as No. 7, set in a cedar handle, ground or honed flat near the point, and curved. The operation is in most respects the same as that described at page 203. The pupil is to be previously well dilated; the needle is to be passed through the cornea, and then made to lacerate the capsule freely, and break up the structure of the lens as far as can be readily done without disturbing the iris. The needle may be entered either at the centre or near the circumference of the cornea. The practice of Saunders and Himly, of passing it through the centre, allows a freer action upon the lens without risk of injuring the iris, but is apt to leave a sort of gauze-like central opacity upon the cornea, as I have observed in several cases which had been operated on by Himly. Dr. Jacobs prefers to enter it near the circumference—a practice which I have followed in the few cases in which I have performed this operation.

Operation by drilling when the capsule is opaque and the pupil adherent.—In cases of this description Mr. Tyrrell frequently employed with success a modification of the anterior operation for solution, which he denominated *drilling*. A fine straight needle is entered near the outer edge of the cornea, and carried through the narrowed pupil, through the capsule, and for the sixteenth of an inch into the substance of the lens. The handle is then rotated like a drill between the thumb and fingers, to enlarge the opening and let in the aqueous fluid to absorb the lens. The operation is to be repeated every three or four weeks, drilling at each time a new orifice in the cataract.

"I think," says Mr. Tyrrell,* "upon the average, I have had to repeat the operation seven or eight times before I have been satisfied that the lens has been removed; consequently the cure has been extremely tedious; but as the plan incurs very little risk, and does not confine the patient for more than three or four days after each operation, there can be no further objection than the slowness of its effects, which is more than counterbalanced by the success of the treatment."

Third method.

Extraction.—This method consists in the extraction entire of the cataract through an opening in the cornea made with a knife of a peculiar shape, and is denominated *Keratotomy*. Though apparently known to the ancients, and practised by Antyllus and Lathyrion, as would appear from the writings of Rhazes and Avicenna, this operation of extraction through the cornea was only brought into general notice by Daviel, who gave the first complete description of it about the middle of the last century. Since that time, it has been brought nearly to perfection by the labours of Wenzel, Richter, Barth, and especially of Ware and Beer. Extraction of the lens by an incision through the sclerotic coat, (*scleroticotomy*), as recommended and practised by B. Bell, Quadri, and others, need only be mentioned as an historical fact, as the process has with great propriety been utterly abandoned.

There are three modifications of this operation for extraction through the cornea, (*keratotomy*), which are designated according to the part of the cornea which is divided, viz: the *inferior*, the one most commonly employed, in which the lower half of the cornea is incised; the *superior*, in which the upper half is cut; and the *oblique*, in which the outer portion is divided in a slanting direction from above downwards and slightly inwards.

The operation in each of these modifications is divided into three stages: 1, *the incision through the cornea*; 2, *the opening of the capsule*; 3, *the removal of the lens*.

When the section of the cornea is made, the capsule frequently gives way before the lens, so as to allow the latter to escape. The first and second stages of the operation then appear but as one; and in the process of Wenzel, the same result is obtained by making the point of the cataract knife during the section of the cornea act on the front of the capsule.

Instruments.—The instruments required consist, 1, of a *knife or keratome for the section of the cornea*. Two of these should be at hand, for fear that, by some inadvertency, the point or edge of one might get blunted. Knives of various forms have been devised, but those most commonly approved are the triangular knife† of Richter and Beer, shown at Plate XLVIII., and the elliptical one of Wenzel. The scissors of Daviel, or a small knife, shaped at the end like a probe-pointed bistoury, should be at hand. To enlarge the opening of the cornea, when the regular section has been interrupted by a fixed prolapsus of the iris before the

edge of the knife, or from a fear, when there is great nervous agitation of the patient, that the muscles might contract too suddenly on a free section and propel the vitreous humour.

2. *One for division of the capsule*, called the *cystotome*. A couching needle may be employed for this purpose, or the small hooked-knife or *serpette* of Boyer, which has a small curette at the other end of the handle occasionally useful in the removal of fragments of the lens.

3. *Those for the removal of the lens and capsule.*—These are required in case it should not be deemed prudent, as in injury of the vitreous humour, to apply pressure to expel the lens, or if any opaque shreds of the capsule remain after the escape of the lens. A delicate hook, or cataract tenaculum, should be at hand for the extraction of the lens, and a pair of slender forceps for the removal of the shreds of capsule.

4. *Those for separating the lids and steadying the ball.*—All the mechanical measures for this purpose have, as a general rule of practice, been discarded by modern surgeons, as the object can be much more safely accomplished by the fingers of the surgeon and his assistant. But in case the fissure of the lid be narrow, or the eye a little sunken, Pellier's elevator or Adams's speculum will be found useful, though especial care should be observed during the operation, that they do not make pressure on the ball so as to cause the escape of the vitreous humour.

The chief points to be observed in the operation of extraction, are, that the incision through the cornea shall be sufficiently large, extending from a third to a *little* more than half of its circumference, smooth and semilunar in shape, and made in the cornea *near* its place of junction with the sclerotic coat,—that the opening of the capsule be effected without unnecessarily lifting the flap of the cornea, and without injury or contusion of the iris, and that the removal of the lens be effected slowly and carefully—to prevent the protrusion of the vitreous humour.

1. *Inferior section of the Cornea.* (*Inferior Keratotomy.* Pl. XLVIII. fig. 1.)

1. *Section of the cornea.*—The patient and assistant being conveniently placed, and the eye steadied as described above, the surgeon, holding the knife like a pen between the thumb and first two fingers, and resting the hand by the two smaller fingers on the zygomatic arch, enters the point perpendicularly to the rounded margin of the cornea, a little above the transverse diameter of the eye, and the twentieth of an inch from the anterior margin of the sclerotic coat—the handle of the knife standing in a horizontal direction, and the edge presenting downwards. As soon as the point becomes visible in the anterior chamber, the blade of the knife is to be brought in a direction perfectly parallel with the iris, and pushed by a sort of extension movement of the fingers steadily across the clear space of the anterior chamber, till the point touches the opposite side of the cornea, which it should traverse from within outward, at the same distance as before from the sclerotic margin, as shown in fig. 1. The knife is then to be carried on in the same direction, until the incision is nearly completed. But to avoid injuring with the point, the caruncula lachrymalis and other parts at the internal canthus, the handle of the instrument (the blade of which by its hold on the cornea commands the eye), is to be inclined gently during the step

* Practical Work on the Diseases of the Eye, &c. By Frederick Tyrrell: London, 1840. Vol. 2, p. 464.

† The triangular knife of Richter, such as is shown in the drawing, may be advantageously modified by rendering it shorter, and thus increasing relatively its breadth. As thus modified, it will be less likely to wound the parts in the inner canthus, or have the iris to fall before it in a fold.

last described, towards the temple, by a slight rotation of the hand over the joints of the phalanges which rest on the zygomatic arch. The incision of the cornea is now to be completed. The surgeon pushes the knife slowly on, pausing a moment before he divides the last attachment of the corneal flap in order to carry the end of a finger into the internal canthus to protect the parts, as well as to allow the contraction into which the muscles of the ball have been thrown by the incision to subside, as this might otherwise cause the sudden protrusion of the lens and vitreous body on the completion of the cut. As soon as the knife is removed, the upper lid is allowed to descend, and the eye kept closed for a few moments before the other steps of the operation are proceeded with. During the section of the cornea, the operator must be particularly cautious not to retract or twist the blade, as this would occasion a premature loss of the aqueous humour, and bring the iris under the edge. The cut must be made without sawing or pressure downwards, merely by a gentle onward movement, so as to divide the inferior segment of the cornea at the same distance from the sclerotic margin at which the knife was entered. When the patient has sufficiently recovered from the emotion caused by the section of the cornea, we proceed to the second stage of the operation.

2. *The division of the capsule.* (Fig. 2.)—The assistant again raises the upper lid, observing the greatest care to avoid making any pressure on the ball. The operator depresses the lower with his fore finger, and bears softly with the end against the lower part of the ball, in order to cause a slight elevation of the corneal flap, and render easier the introduction of the instrument for opening the capsule, as seen in fig. 2. The pressure serves also to advance the cataract toward the pupil, so as to facilitate the division of the capsule.

If the *serpette* or *cystotome* of Boyer is employed, as shown at fig. 2, it must be insinuated gently with its back upward, and by a slight rotatory movement under the corneal flap, so as to carry

the blade flat to the upper part of the pupillary opening. The edge is then to be turned downwards, and the capsule divided freely with some gentle movements of the point from side to side, as well as over each semi-circumference, avoiding carefully all pressure upon the lens, or any lesion of the iris.

If the spear-pointed needle be employed, to which a decided preference is given by the German surgeons, the neck of it is to be passed under the lower margin of the flap, with the point directed towards the inner canthus, and the edges looking upwards and downwards. The needle is then to be retracted horizontally till the spear point comes opposite the pupil; the point is next turned on the capsule, so as to divide it into several square pieces. The needle is then to be withdrawn flatwise, obliquely, and without lifting the flap. Jüngken merely divided the capsule by a single incision—but this, though it admits readily enough the escape of the lens, is an objectionable practice, inasmuch as it renders the patient more liable to secondary cataract.

3. *Expulsion of the cataract.* (Figs. 3, 4.)—If the incision in the cornea has been made sufficiently large, and the capsule freely divided, the lens is commonly dislodged immediately behind the cystotome, either by the contraction of the muscles of the ball, or the retraction of the divided capsule. If such should not be the case, the operator is to press gently against the ball, with the finger sustaining the lower lid, until the lens stands with its largest diameter in the pupil, and its margin slides through, as shown in fig. 3. If deemed necessary, the scoop or curette may be introduced to favour the exit of the lens, or remove any fragments into which it may have been broken by its passage through the pupil. As a general rule, however, it is best not to employ the curette for either of these purposes, from the danger of giving rise to increased irritation. The fragments must necessarily be soft, and if they are not large, will speedily become dissolved; and the expulsion of the lens can be more safely effected by slight pressure with the handle of the cystotome over the upper lid, as shown in fig. 4.

PLATE XLVIII.—CATARACT.

OPERATION BY EXTRACTION.—INFERIOR SECTION OF THE CORNEA.

Fig. 1.—Section of the cornea with the triangular knife of Richter and Beer.

In the stage of the operation shown, the punctuation of the cornea has been made at its outer margin, and the point of the knife (*e*), glided across the anterior chamber in front of the iris, is brought out by a counter puncture on the side next the nose. The lids are separated by the fore and middle fingers of an assistant (*a*) and the fingers of the surgeon (*b*). The pressure of the ends of the fingers serves to steady the ball. The knife by being carried on cuts out at the lower semi-circumference of the cornea.

Fig. 2.—Incision of the capsule with the cystotome or *serpette* of Boyer, which is introduced with the right hand of the surgeon. A cataract needle, as observed in the text, is very commonly substituted for this instrument.

Fig. 3.—Vertical section of the ball, seen from the side.

This drawing exhibits the tract of the lens in its expulsion from its seat, by the double influence of the pressure of the fore finger (*d*) on the lower lid, and the handle of the cystotome (*c*) on the upper. At *f* the lens is represented in its natural position, before its dislodgement. At *g* the same lens is represented as having left its seat, with its lower edge tilted forwards by the slight force applied by the finger (*d*), pressing downwards and backwards the inferior segment of the iris (*h*), upwards and forwards the superior segment (*i*), and raising the flap of the cornea as it falls from the eye upon the nail of the finger below.

Fig. 4.—Expulsion of the lens.—Front view of the same process described under fig. 3.

Fig. 5.—Removal of any opaque portions of the capsule, seen remaining after the expulsion of the lens.

Fig 1

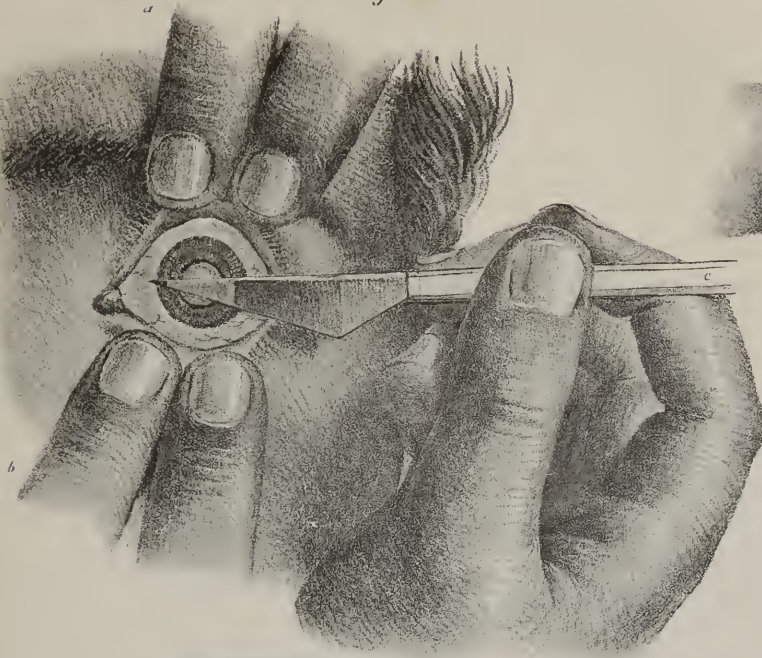


Fig 2

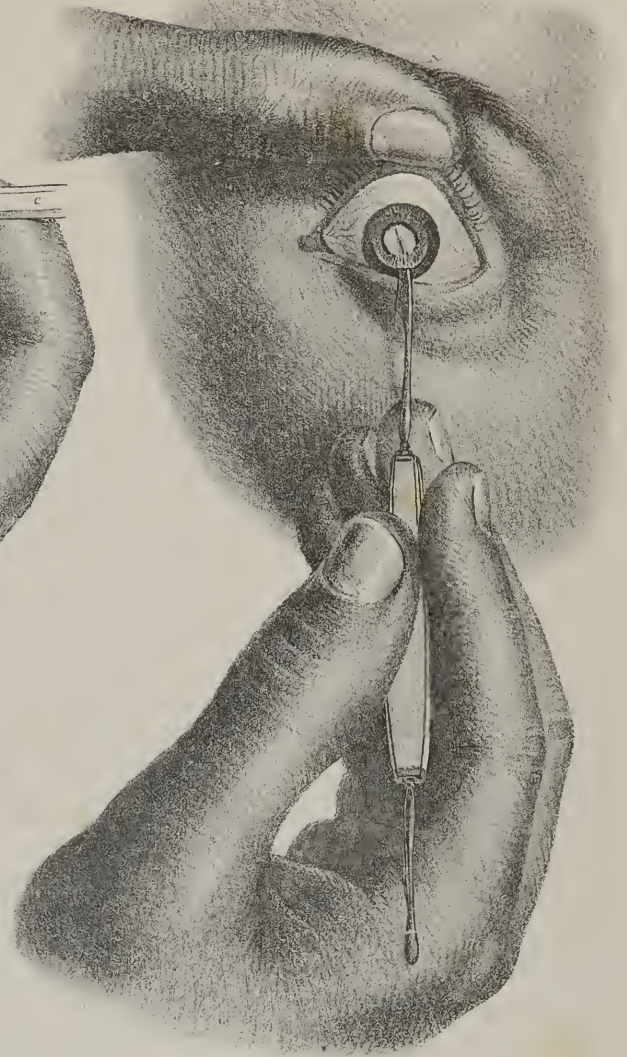


Fig 4

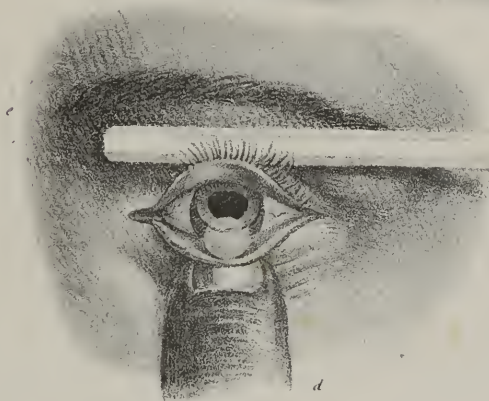


Fig 5

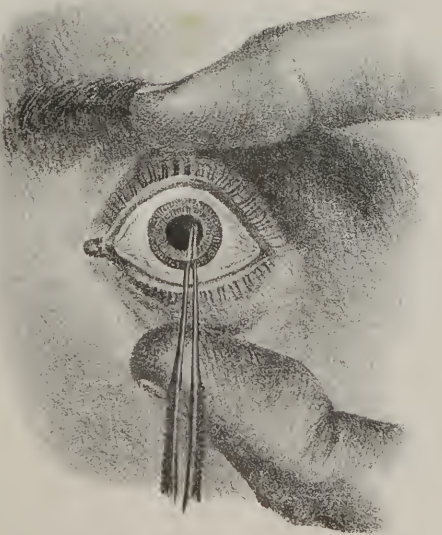
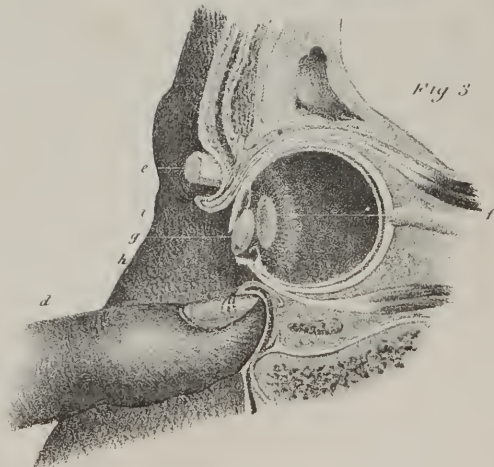


Fig 3



If by this means the lens is not readily made to lift the corneal flap and fall upon the finger nail of the surgeon, it may be removed from the lips of the wound with the needle or eurette.

If the pupil is clear, the operation is now terminated. Very frequently, however, the remains of the capsule, especially if it be opaque and more firm than natural, will be seen floating in the pupil, or more or less adherent to its margin. These may be removed with a pair of delicate forceps, carefully introduced, as seen in fig. 5, the lids being again separated for the purpose, either with the thumb and fore finger of the surgeon's other hand, or by the aid of an assistant. But it would be a safer practice to avoid making much traction on the shreds of the capsule through fear of causing an escape of the vitreous humour, and follow the advice of Mr. Tyrrell, allowing such portions to remain as are firmly adherent, and trust to getting rid of them subsequently by a needle operation.

Dressing.—As soon as the operation is completed the eyes are to be closed, care being taken that the flap of the cornea lies in its proper position, and that no air has entered between the lips of the wound. If any bubble of air should be observed, it is to be driven out by a slight pressure upon the cornea with Daviel's scoop, or by merely rubbing the eyelids. The parts are to be wiped dry with a fine linen cloth, a small strip of adhesive plaster is to be applied over the lids, to hold them together, and a linen compress fastened by adhesive straps over the eyebrows, so as to form an easy but perfect shade for the eye; or (a plan to which I have commonly given the preference,) a light compress of old linen may be laid over the closed lids and kept applied by gentle pressure with linen strips, attached to the front and back portions of a close fitting cap. The patient is then put to bed in a darkened room, and the after-treatment conducted according to the principles laid down in the treatises upon this subject.

Simple and safe as this operation would appear from the description, it is subject during its performance to many dangers and difficulties, which cannot always be obviated by the most skilful and practised hand. The flap of the cornea should never, *under any circumstances*, exceed the five-eighths of its circumference, as it would otherwise increase the risk of the loss of the vitreous humour, and form a flabby fold liable to gangrene. If made too small, on the other hand, there is danger that the iris may become contused in the transit of the lens. The entering puncture ought also to be made nearly a line above the transverse diameter of the cornea, and the point of exit on the opposite side of the membrane usually as much below, in order that the flap may be less liable to be disturbed by the action of the lower lid. In piercing the cornea, it is possible that the point of the knife may be managed so badly as to enter in an oblique direction and get between the laminæ: this is more likely to occur if at the moment of transfixion the eye should be turned towards the inner canthus. If the error is soon detected, the knife may be retracted and entered anew; but if it has penetrated far between the laminæ, all further proceeding should be suspended till the wound has completely healed. If the point should catch the iris, the knife should be slightly retracted so as to free this membrane. If from the premature escape of the aqueous humour, after the counter puncture is made, the iris prolapses before the edge, it was the advice of Beer to press quickly with the end of the fore finger upon the cornea

over the blade of the knife, so as to cause the iris to recede, and allow the incision to be completed without injuring that membrane. When neither pressure nor friction with the end of the finger causes the iris to retract, we may, as directed by Mr. Guthrie, bring the relaxed cornea forward with the knife, pressing at the same time with the fore finger flat on the blade, and thus disentangle it from the iris so as commonly to get room to finish the section safely. Jüngken preferred to excise at once the portion of the iris prolapsed before the edge of the knife; but it is better to try to effect the disentanglement, and when we cannot, especially in those still more embarrassing cases where the iris falls forward so as to stick to the cornea, we should withdraw the keratome if the iris be threatened with much injury, and finish the incision with a small curved and probe-pointed knife, or a fine pair of curved scissors. The injurious consequences, however, of shaving off a portion of the pupillary margin of the iris has been much overrated, and it is frequently found better to make this sacrifice than to risk the ultimate success of the operation, by more than one or two gentle efforts to disentangle it from the edge of the knife. Should the assistant allow the upper eyelid to slip from under his fingers, which ought never to happen, the operator should stop the progress of the knife until the lid is again raised. If this accident happen in the method by incision of the upper half of the cornea (described at p. 210), the canthus is liable to be injured by the upturned edge of the knife. If it occur during the lower section, it will most likely invert the flap formed, and cause a sudden prolapse of the lens and vitreous humour. The loss of the humour may occur, also, as the consequence of undue pressure upon the eyeball with the finger, or from muscular contraction merely, especially if it be found more fluid than usual. The eyelids in either case have to be closed immediately, and retained in that condition with adhesive plaster, as no attempt to restore the prolapsed humour will be found beneficial. A loss of a small portion of the vitreous humour may not be attended with any disadvantage. The loss of a third or even a half of it, according to Siehel, will occasionally be replaced by the secretion of aqueous fluid, or a re-development of the vitreous humour, to such an extent as to restore the function of the organ.

During the opening of the capsule also, many circumstances may arise embarrassing to the operator. The pupil may contract and prevent the discharge of the lens; the cataract may crumble into pieces, or if soft, become diffused; parts of the capsule may be left behind, or the iris and vitreous body prolapse.

If the contraction of the pupil is only the consequence of too strong a light falling into the eye, this may be easily remedied; but if it should not dilate sufficiently after the eye is more shaded and has recovered from irritation, the margin of the iris may be divided with Maunoir's scissors, and, according to Rosas, without any ill consequences, the small wound closing after a few days. If the eye be very restless, it is hardly possible to open the capsule without injuring other parts; in such cases Jüngken has given the very doubtful advice, to perform this operation in a darkened room, taking care to give the needle the proper direction.

Sometimes the cataract adheres more firmly to the capsule, and cannot be detached, either by slight pressure or by Daviel's scoop. Here it becomes necessary to take hold of the lens with a fine

hook, and draw it out. If the posterior wall of the capsule is also found opaque after the removal of the lens, Morenheim and Beer have directed either that it be divided with a cataract needle in different directions, until part of the vitreous body enters between the lips of the incisions, so as to hold them asunder; or that the cataract hook be inserted into the capsule and turned several times round on its axis, in order that this, with a part of the adherent vitreous body, may be extracted from the eye. If the iris prolapse and be retained between the margins of the wound in the cornea, we will best promote its retraction by gently rubbing the closed upper eyelid upon the bulb, and then by suddenly opening it, let a strong light fall into the eye.

2. *Oblique section of the cornea. Oblique Keratotomy.*

Process of Wenzel.—This process does not differ from the preceding but by the direction in which the cornea is cut, and in the incision of the capsule being made at the same time with that of the cornea. The knife used is of an elliptical shape. It is held between the thumb and first two fingers, and inclined obliquely, so as to form above, an angle of about 45 degrees with the horizontal diameter of the ball—its point presenting *perpendicularly to the surface* of the cornea at the middle of its superior and external fourth. The knife is then to be entered through the cornea and passed across, so that the point shall emerge exactly opposite, at the middle of the lower and internal fourth. When the point, in traversing the anterior chamber, comes opposite the outer edge of the pupil, it is to be inclined backwards so as to cut the capsule; then brought again to its first direction and carried on to make the counter puncture. When the section of the cornea is completed, it is semicircular, and will differ from the preceding only in its direction being diagonally across the eye. In its other stages, the operation is precisely the same as the one just described.*

The oblique section constitutes an eligible operation, but is now employed less frequently than the inferior, which is the most easy, or the superior, which possesses in a still greater degree, all the advantages attributed to the oblique.

Wenzel's plan of opening the capsule with the point of the knife during the section of the cornea, is considered hazardous; and as it presents no peculiar advantage, save that of shortening the operation, it has been entirely abandoned—surgeons preferring to open the capsule at a second step, as in the operation already described. The operation by oblique section of the cornea may, therefore, be considered as divided into three stages, like the other modes of extraction.

3. *Upper section of the Cornea. Superior Keratotomy.*

Practised in the first instance in exceptional cases, this has latterly been extolled as the most appropriate in general, by Mackenzie, Lawrence, Green, Guthrie, Alexander, Græfe, Jæger and Dupuytren. It is somewhat more difficult of execution than the other processes, exposes the upper lid to the danger of being cut with the knife, and does not afford quite the same facility for the opening of the capsule and the extraction of the lens. And

* By Mr. Lawrence and many other distinguished surgeons, the lancet-pointed or elliptical knife of Wenzel is, in the various modes of extraction, preferred to the triangular knife of Beer, in consequence, as they believe, of its entering the cornea more readily.

in addition the convulsive contraction of the muscles which turn the eye upwards, is sometimes such as to render this section of the cornea difficult and even dangerous. But, on the other hand, it possesses the incontestable advantages of diminishing the chance of evacuation of the aqueous and vitreous humours, and wholly prevents the possibility of the separation of the corneal flap during the cure by the action of the lids, or its irritation by the ciliæ, which, after the inferior section, is found so often the cause of the flap falling into suppuration and gangrene. The tears flow more readily, and are less liable to irritate the wound, which cicatrizes promptly. The iris is less liable to be cut in the corneal incision, and less prone to hernial protrusion during the cure. And, moreover, if the flap should become opaque, to which there is always more or less tendency, the opacity presents less obstruction to the sight than in cases where the section has been made below.

The same instruments are employed in this operation as the two preceding. Jæger and Guthrie have devised double-bladed knives, one blade sliding on the other, in order to insure a safer and more regular division of the cornea; but the bulk of these instruments is said to more than counterbalance any peculiar advantage which they possess.

It is possible for the surgeon to effect the superior division of the cornea, by sitting as ordinary, in front of the patient. Most operators, however, prefer, and with reason, to place themselves behind the patient, and raise the upper lid with the fingers of one hand, while the inferior is depressed by an assistant standing in front. The knife is then to be held in the right hand for the right eye, and in the left for the other, the cutting edge turned upward, the surgeon taking a point of support for the hand by resting the little finger upon the temple above the zygomatic arch.

The *punctuation* of the cornea is to be made by applying the point of the knife perpendicularly upon the cornea, a little above its transverse diameter, and about the twentieth of an inch from the margin of the sclerotic coat. As soon as the point has entered the anterior chamber, the handle is to be inclined backwards, in order to bring the point horizontal and avoid the wounding of the iris. The *counter punctuation* is to be made at a point exactly opposite the place of entry, and the section completed by carrying the knife steadily on, as in the ordinary operation. The division of the capsule, and the expulsion of the lens, are effected as in the processes already described, with the exception that in dislodging the lens, gentle pressure is to be made on the *inferior* lid, from which the fingers of the assistant are to be removed, while the surgeon draws the superior well up to prevent its offering any obstacle to the exit of the lens.

Extraction by the process of Mr. Scott.—Mr. Scott,* considering that the chief difficulty and danger attending the extraction of cataract arises from the force required in the transfixion of the cornea with the knife commonly employed, has invented one of a peculiar sabre-like shape, narrow in the blade, which he asserts can be introduced with the same facility as the needle, and covers the iris so well by the convexity of its edge, as to protect that membrane against the risk of being wounded.

* *Cataract and its Treatment, comprising an Easy Mode of Dividing the Cornea for its Extraction.* By John Scott, Senior Surgeon to the Royal London Ophthalmic Hospital. London, 1843.

"The back of the knife describes a sixth part of the circumference of a circle, the radius of which is ten lines. The chord of the arc formed by the back of the knife is, of course, also ten lines in length, being equal to the radius of that circle; it is, therefore, greater by four lines than the diameter of the cornea, and the blade is consequently quite long enough to complete the section of that membrane without difficulty. The knife is two lines in width at the heel, whence it gradually tapers to the point; it also increases uniformly in thickness, as well as in width, from point to heel, so as to occupy completely the aperture it makes in the cornea, for the purpose of preventing the escape of the aqueous humour.

"In making the upper section of the cornea with this knife, it is to be held in the usual manner, between the thumb and two fore fingers, the two other fingers resting on the patient's cheek, and the handle of the knife slightly inclined towards the side of the face, while the point punctures the cornea on its temporal margin. The handle of the knife is then to be brought upwards with a sweep as the blade traverses the anterior chamber; and when it has punctured the nasal side of the cornea, the handle will be nearly at a right angle with the temple. The knife is then to be carried completely across the anterior chamber. In doing this, great care must be taken to press firmly downwards with the back of the instrument, so that the wound may not be unnecessarily enlarged by its cutting edge. This being accomplished, the point of the knife will have reached the nasal canthus of the orbit, and its cutting edge will be so far beyond the pupillary margin of the iris that it cannot be readily divided in completing the section of the cornea. The point of the knife is then to be carried upwards, the handle being slightly inclined in the opposite direction. The section of the cornea on its nasal side will now be complete, a small portion at the upper and outer part only remaining to be divided; and this is readily done in the withdrawing of the instrument."

*Upper section of the cornea by the process of M. Bodinier.**

This gentleman has devised an ingenious instrument, for making the section, consisting of a knife and needle conjoined, which has long been a favourite idea with some of the German surgeons. The needle is shaped like the back of a Richter's knife, supposing this to be severed by a longitudinal cut from the blade, with the exception that it is longer in the shank, and has a triangular cutting edge at the point. The knife, of the shape of the blade left by the same supposed longitudinal cut, can be withdrawn at will into the handle, or pushed by a button along the needle, up to the triangular point of the latter.

M. Bodinier rests the head of the patient upon a pillow, which he places upon his thighs. He then raises the upper lid with the fore finger of one hand, rests the pulpy end of the middle finger upon the internal canthus, so as to steady the ball and partly depress the lower lid. He then with the instrument in the other hand, punctures the cornea with the needle, (the blade being retracted in the handle,) passes it in front of the iris till it comes opposite the pupil; next he passes it through the pupil and freely lacerates the capsule of the lens; after which he brings it again in front of the iris and makes a counter-punctuation of the cor-

nea on the side next the temple. The cornea is now spitted as it were with the needle, which holds the ball firm, and admits of the blade being pushed forward with the thumb, so as to make, according to this surgeon, the section of the upper half of the cornea with great precision and safety. The instrument is then withdrawn, and the lens, if it does not fall forward of itself, is to be removed in the usual manner. Among the many advantages of this process enumerated by M. Bodinier is that of its enabling the operator to dispense with the aid of assistants.

4. Lateral section of the Cornea. Method of M. Furnari.

This process, like the two just described, is altogether new, and requires to have its merits further tested before it can be assigned any rank in practice.

The instruments required are, 1, a double lance-headed knife, which consists of an ordinary lance-shaped blade, from the point of which projects another minute lance-shaped knife formed like a cataract needle, and slightly curved so as to divide the capsule of the lens, while the larger instrument makes a lateral section of the cornea: 2. Forceps of a peculiar kind, with scooped and dentated points, for seizing the lens and capsule—the place of which, however, may be well supplied by those of the ordinary form.

The patient and operator being placed as in the usual process for extraction, and the lids separated, the smaller lance is to be entered at the transverse diameter of the cornea, about the twentieth of an inch from the sclerótica. It is to be carried horizontally forwards through the anterior chamber, and at the time it comes opposite the centre of the pupil, the larger lance which follows it will be found to have made a section of the cornea sufficiently large for the exit of the lens. The handle is then to be inclined slightly forward so as to throw the smaller instrument on the capsule, which is to be divided in a zigzag direction. The knife is then withdrawn, and through the opening in the cornea the pincers are introduced to seize the opaque body, which is to be removed by gentle traction. If the lens be soft, and break in pieces, such of the fragments are to be removed as can readily be got away, and the remainder broken up, trusting to their ultimate removal by solution, as in the ordinary process by division. If the lens be hard and large, a circumstance rarely met with, it is to be broken up with the forceps and the fragments removed.

The advantage of this process, according to M. Furnari, is the smooth and regular incision of the cornea, obtained by puncture merely, and of but small extent, which prevents the prolapsus of the iris, the loss of the vitreous humour, and the introduction of the edges of the lids between the lips of the incision. The instruments, however, are not of easy fabrication, and the method, on the whole, seems to present few advantages over the following, which I have in two instances, when the lens was small and hard, successfully practised. It is moreover liable to the same objections, viz: the liability, from the repeated introduction of the forceps, of irritating the iris as well as the cornea, especially when the lens, in attempting to withdraw it, is found of a size disproportionate to the corneal section. The latter objection, however, might readily be obviated by the use of an instrument with a broader blade, or by enlarging the previous incision with the knife or scissors.

* Thèse pour la Doctorat en Chirurgie. Paris, 1844, by J. V. Bodinier, M. D.

Extraction through a section of one-third of the circumference of the cornea.—This is the method usually adopted when the lens has fallen spontaneously into the anterior chamber, or gets there by accident in the operation for couching or division. "Of the reality of some of the advantages attending this process," says Mr. Mackenzie, "I am able to speak decidedly, as I have employed this method of extraction in a variety of cases. I prefer it when it is my object to extract a capsular cataract, or when I have reason to believe that the vitreous humour is dissolved. The following is the plan which I have successfully adopted in cases of *capsular* or *siliquose* cataract, the lens having been absorbed, either spontaneously or in consequence of an accidental wound of the capsule, or removed by previous operation. I place the patient in a horizontal position, and pass a curved needle through the sclerotica, with which I gather together the opaque capsule into a mass, which I then push through the pupil. With the 'common' extraction knife, I open the upper or temporal edge of the cornea to a third of its extent. I then introduce a hook, lay hold of the capsule, and either immediately extract it, or, if I find this opposed by any adhesion, turn the instrument (hook) round on its axis till the membrane is detached. In one case in which I found the capsule so strongly adherent to the iris that I was afraid I might sooner sever the latter from the choroid than extract the capsule, I contented myself with prolapsing the capsule through the wound of the cornea, clearing in this way the pupil, and restoring a very useful degree of vision. Under such circumstances, the iris scissors might be very advantageously employed in dividing the half detached surface."*

Mr. Travers, Sir W. Adams and others, have employed a similar process for the extraction of *firm* cataracts through a small section of the cornea. The pupil being previously well dilated with belladonna, which can always be safely done when the cornea is opened to but a small extent, a small bent needle is passed through the sclerotica to slit open the capsule, and tilt the lens forward into the anterior chamber through the pupil. In this position it is fixed by the needle, which is then committed to the charge of the assistant. The surgeon then opens the circumference of the cornea to one-third of its extent, withdraws the needle and introduces the hook, with which he lays hold of the lens and extracts it. In the two instances above alluded to, in which I have operated by the small section of the cornea, I succeeded in laying hold of and removing the lens by a small curved needle *introduced through the corneal wound*; and notwithstanding the pupil had contracted considerably after the section of the cornea, its edges yielded to the slight effort which was required to withdraw the lens. The circumstance of the pupil nearly always contracting after the corneal section, however large it had been expanded before under the influence of belladonna, renders the process inappropriate when the lens is large. But, as the lens when large, is usually found soft or fluid, the operation should be finished in the manner several times employed by Mr. Travers,†

* Treatise, p. 699.

† This practice of Mr. Travers was a modification of that of Mr. Gibson, of Manchester, who, in order to avoid the protractedness of the cure by division, was in the habit of first breaking up the lens by a needle through the sclerotica, and two or three weeks afterwards making a small section of the cornea, and scooping out the fragments.

viz: by rupturing the capsule either with the point of the extraction knife, at the time of the section, or by a needle subsequently introduced. The cataract, if fluid, will then discharge itself with the aqueous humour—if flocculent, it takes an oblong shape, and frequently passes out entire—if caseous, it may be removed piecemeal with the curette; and should any portion of the capsule be found opaque, it may be taken away with the hook or forceps. By this process, no necessity exists for making lateral pressure on the ball, and the risk of the escape of the vitreous humour is in consequence thereby greatly obviated.

5. *Mixed method of Quadri.*

This consists of a combination of the ordinary method of depression with keratonyxis. A needle is first introduced through the sclerotica to depress the lens; another needle, to which a small pair of forceps is attached, is then introduced through the cornea in order to seize the fragments of the capsule and destroy them if soft, or draw them outwards through the corneal puncture, if they are found resisting. The method, however, has not been received with favour.

Remarks.—From the description of the various methods for the removal of cataract, it will be found that each is attended with its peculiar advantages and inconveniences, and that no one can be selected as suited to universal application. As a general conclusion, it may be said that the process by division and solution is the safest method; that by depression, the most speedy; that by extraction, the most complete, but at the same time the most hazardous and requiring the greatest amount of experience and manual dexterity, since, unlike the two former, if not at once successful, it leaves no chance for relief by any future proceeding. It may, moreover, be urged that extraction is contra-indicated in all cases, except when the lens is small and hard, the eye prominent, the anterior chamber of good size, and the condition of the eye, as well as the general health of the patient, sound and satisfactory.

ON SECONDARY CATARACT.

Every obstruction in the posterior chamber of the eye, caused by parts of the lens or capsule remaining after the operation, is called secondary cataract.

The portions of the lens left, after the operation by division, generally disappear by solution; the eye in general only requiring to be guarded against external injuries, and the pupil occasionally dilated with belladonna. When the fragments do not appear to diminish after repeated division with the needle, it has been proposed to assist their solution by puncturing the cornea and discharging the aqueous humour. A safer plan, however, and the one more commonly practised, is to remove them with the needle by the posterior operation for depression, or extract them by a small incision through the cornea.

The only remedy for capsular secondary cataract is its removal by one of these methods last named, absorption having no effect upon it. If the capsule be not very thick or tough, which may be told by its being of a grayish hue, it is best, after dilating the pupil with belladonna, to detach it at the circumference with a needle, introduced through the sclerotic coat or cornea, and re-

Fig 8



Fig 5



Fig 6

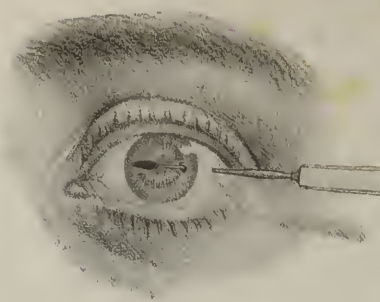


Fig 7



Fig 3

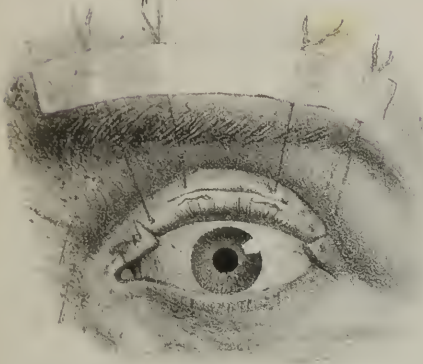


Fig 1

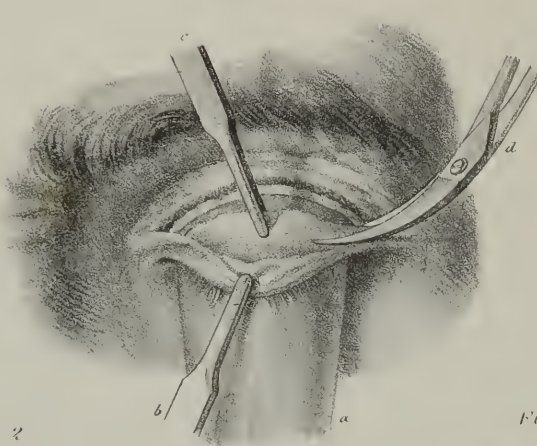


Fig 4

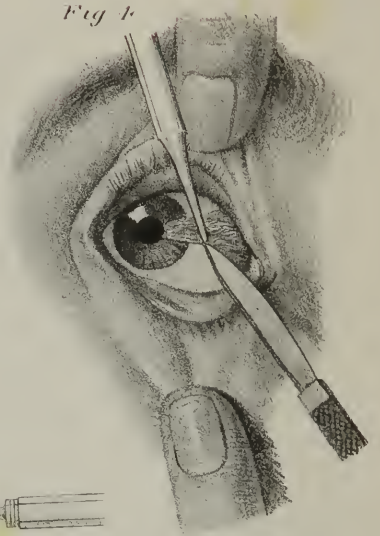


Fig 2



Fig 17



Fig 14

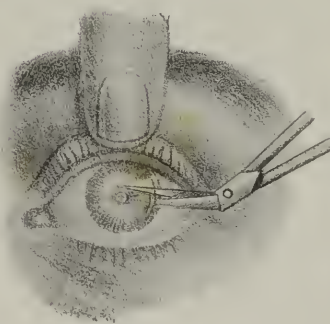


Fig 15



Fig 16



Fig 13

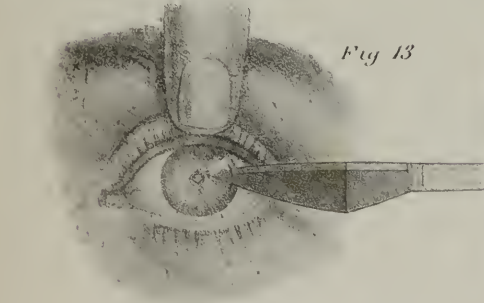


Fig 9



Fig 10

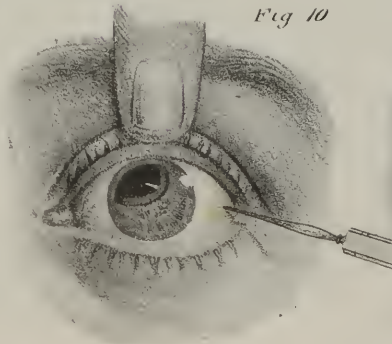


Fig 11

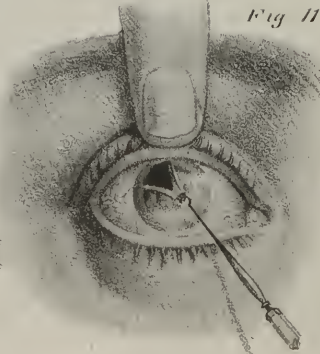
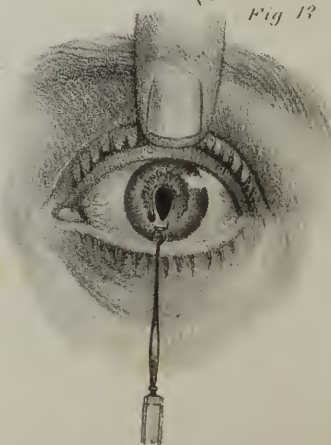


Fig 12



move it from the axis of vision, or at least clear a space in its middle so as to form an opening corresponding to the pupil. If the capsule be very firm and parchment-like, as it usually is when it presents a glistening white aspect, it is not easily divided with the needle. It may then be loosened, rolled on the needle, and depressed into the vitreous humour. It will frequently, however, be found to reascend as soon as the pressure of the needle is taken off. It may become then necessary to make a small puncture in the cornea, and extract it with the hook or forceps. If parts of the capsule have grown adherent to the pupillary margin, the points of connection may be detached—if small, by the posterior operation with the needle; but if the adhesion is very extensive, and complicated with an organized layer of lymph obstructing the

pupil, the formation of an artificial pupil will be found the best resort.

ARTIFICIAL PUPIL.

The formation of an artificial pupil consists in the establishment of a new opening through the iris, and is required in a variety of cases, which for convenience, may be divided into the simple and complicated. The simple consists of the closure or the accidental obliteration of the natural pupil (*artresia pupillæ*), resulting from the effusion and organization of lymph between its edges, or that of a layer covering the front of the iris; or when, the pupil remaining natural, the central portion of the cornea has

PLATE XLIX.—ENTROPION. PTERYGIUM. ARTIFICIAL PUPIL. STAPHYLOMA.

ENTROPION.

Figs. 1 and 2.—*Excision of the tarsal cartilage.* (*Process of Saunders.*)—A thin plate of horn (*a*) is passed under the lid and held by an assistant, who at the same time draws the edge of the lid down upon it with the forceps (*b*). The skin has then been divided near the palpebral fissure, dissected upwards, and an incision made down upon the horn plate through the conjunctiva and margin of the tarsal cartilage. The cartilage is then seized with the forceps (*c*), as shown in the drawing, and excised near its free border with the curved scissors (*d*). The edges of the skin are then to be united with three sutures, as shown in fig. 2.

Fig. 3.—*Section of the tarsal cartilage for the cure of entropion.* (*Process of Guthrie.*)—Two vertical incisions have been made in the lid, and an elliptical portion of skin excised between them, and the wound closed by two ligatures passed in the form of loops through the lower segment. The edges of the lateral sections are closed by two looped threads. The free ends of the ligatures are then attached by an adhesive strap to the forehead, so as to keep the middle part of the lid elevated and allow the lateral cuts to heal slowly by granulation.

PTERYGIUM.

Fig. 4.—*Excision of the pterygium with the bistoury and scissors.* (*Process of Rognetta.*)

ARTIFICIAL PUPIL.

Fig. 5.—(*Process of Cheselden.*)—A needle with a cutting edge has been introduced behind the iris, and is seen dividing it from behind forwards.

Fig. 6.—(*Process of Sharp and Adams.*)—Transverse incision of the iris from before backwards.

Fig. 7.—(*Process of Janin.*)—Vertical section of the iris with a pair of fine scissors introduced through a wound previously made in the lower portion of the cornea.

Fig. 8.—(*Process of Maunoir.*)—Double vertical incision of the iris, made through a similar opening in the cornea.

Fig. 9.—(*Process of Gibson.*)—Excision with the hook and scissors of a portion of the iris. In the drawing, instead of the iris being hooked out and excised at the outer margin of the corneal incision, according to the usual process of this author, the centre of the imperforate iris has been raised with the hook and the scissors introduced through the wound, to remove the elevated fold.

Fig. 10.—(*Process of Scarpa.*)—Detachment of the iris at its superior and internal border with a cataract needle.

Fig. 11.—(*Process of Langenbeck.*)—Detachment of the iris and insertion of the flap in the wound of the cornea.

Fig. 12.—(*Process of Langenbeck.*)—Extension of the natural pupil—one margin of which is drawn down with a delicate hook, and left wedged between the lips of the small corneal incision.

Figs. 13, 14, 15.—(*Process of the Author.*)—A puncture is made through the outer margin of the cornea with a cataract knife, the point of which, as shown in fig. 13, is carried also through the iris from before backwards, but without injuring the lens or its capsule. Through the opening in the cornea is introduced a delicate probe-pointed pair of scissors—one blade of which is passed also through the opening of the iris, and behind this membrane to near the centre of the former pupil, as shown in fig. 14, in order to make the transverse cut. A quadrangular pupil is immediately formed, provided the iris is healthy and not adherent on its posterior surface,

become opaque, so as to prevent the rays of light entering in such a direction that they may impinge upon the retina. The cases of complication are, 1st, those in which the pupil is closed and the iris adherent by its posterior face to the capsule of the lens (*synechia posterior*), the whole iris, and particularly the new membrane closing the pupil, being more or less concave on the front surface, and the affection almost always in addition accompanied with capsular cataract; 2d, those in which the iris is adherent by its anterior face to the cornea (*synechia anterior*), the consequence of inflammation merely, or the result of a prolapsus of the iris through a wound or ulcer of the cornea, and which may or may not be complicated with cataract. Either of these cases of synechia may be complicated with flattening of the cornea, with opacity of this membrane to a greater or less extent, with staphyloma of the cornea or sclerotic coat, or with glaucoma, amaurosis, or great atrophy of the vitreous humour (*synchisis*). The latter three, however, are complications which render useless all attempts at operation, for they necessarily imply a destruction of the function of the retina.

The conditions necessary to success, or rather those which justify the operation for artificial pupil, are the following.

1. That the eye should be free from existing inflammation, or any serious alteration of its deep-seated contents, such as atrophy or dropsy of the ball, varicose condition of the choroid coat, accompanied with thinning of the sclerotica, and the system clear of any general taint, such as that of syphilis or scrofula.

2. That the cornea should be transparent over at least a fourth or third of its surface, free from staphylomatous projection, and without any opaque effusion within the anterior aqueous chamber.

3. That the retina should have preserved its sensibility, and be capable of distinguishing between light and darkness, whatever is the degree of morbid alteration for which relief is demanded.

4. That the other eye should be incapable of useful vision; for if it were, the new pupil of the opposite side could not be established in parallelism with the other, and the patient, without seeing better, would be exposed to the risk of sympathetic inflammation of the better eye, which might result in its destruction.

Remarks.—The age of the patient influences also considerably the prospect of success. In young subjects, in consequence of their indocility during the operation, and the proneness of the eye to consequent inflammation, the chance of ultimate success, all other circumstances being the same, is not so great as in the adult; and in very old persons, though inflammation is little liable

to follow, the result has usually been still less happy. In the simple cases requiring operation, we should, when the cornea is wholly transparent, make the new pupil as near as possible upon the site of the old, in order to avoid any liability to strabismus. In that variety in which the cornea is merely opaque at the centre, we have a choice of the whole periphery of the iris for operation. An artificial pupil formed in the lower hemisphere of the iris, will be found to admit the greatest amount of light. One on its outer side will, if the cornea be opened, be most easily formed and with the least risk of instrumental injury, affords a wide range of vision, and if strabismus should follow, it will be of the internal and least disagreeable kind. From these considerations I have always under such circumstances preferred, in my own operations, the external hemisphere for the seat of the new pupil, and have had good reason to be satisfied with the choice. If it be made on the side next the nose, the prominence of that organ will interfere with the sight, and an external squint will be sure to follow. If it be formed in the upper segment of the iris, the upper lid will shade it to a greater or less extent. But when the opacity involves not only the centre but the adjoining part of the structure of the cornea, we have not the same freedom of choice, as it is necessary to make the opening opposite the clearest portion of this membrane. And if the cornea be opened for the purpose, the puncture should be made through its opaque portion, as this heals as readily as any other, and we avoid the risk of increasing the extent of the opacity. The section of the iris should, however, be made if possible on a part which has not suffered from previous disease, as the orifice will be found less likely to close up by subsequent inflammation. But when the opacity extends from one side but a small degree beyond the centre of the pupil, we may sometimes avoid the necessity of this delicate operation by a division of one of the recti tendons and its adjoining fascia, so as to produce a squint in the opposite direction, and turn the transparent portion of the cornea more in front.

I have four times practised this operation*—twice upon the superior rectus, once upon the external, and once upon the inferior—the last of which was attended with the most decided improvement of vision. Nothing more, however, than a considerable alleviation is to be expected by this operation, as the relative position of the opacity and the pupil must still remain the same.

* Two of these operations were performed as early as the winter of 1840 before the class of the Philadelphia Hospital.

which ultimately assumes the form shown in fig. 15, which has been copied from nature four years after the performance of the operation.

Fig. 17.—Probe-pointed needle, curved and cutting near the point, occasionally used by the author instead of the scissors for the division of the iris.

STAPHYLOMA.

Fig. 16.—Removal of an elliptical portion of the protuberant cornea, as performed by the Author.—The cornea, which is most opaque and prominent at its outer portion, is turned inwards towards the nose. Two incisions forming an ellipsis have been made with a delicate scalpel through the surface of the thickened mass of the cornea, opening at their inferior extremity into the aqueous chamber. The lower end of the flap thus loosened is raised with a hook, and the piece detached completely with the iris scissors. The aqueous humour escapes, and the margins of the divided cornea come together.

As regards the complicated cases,—the anterior or posterior adhesions of the iris, and the opacity of the lens or its capsule, are not positive counter-indications to the operation, though they render it more difficult, and influence very considerably the choice as regards the manner in which it should be performed.

To be serviceable, an artificial pupil should be at least from half a line to a line and a half in diameter. Below this size vision would be but imperfect, however good was the condition of the retina—and it would be confused if the size of the opening was much greater.

There are between fifty and sixty processes, differing more or less from each other, which have been devised for this operation, the greater part of which involve the destruction of the lens even when it is not opaque. They may all, however, be arranged into four classes or methods: viz., by incision (*Cheselden*), excision (*Wenzel*), detachment of the iris (*Scarpa*), and extension of the natural pupil (*Langenbeck*).

First method.

Incision. Corectomia--Iridotomia.—Devised and put in practice by Cheselden, this method has been variously modified by different surgeons.

1. *Process of Cheselden.* (Pl. XLIX. fig. 5.)—The patient is placed as in the operation for couching a cataract. A narrow, thin, sharp knife, pointed like a needle, or a sort of needle with an edge on one side, is to be passed through the sclerotica, as in the ordinary operation for couching, and carried flatwise behind and parallel with the iris. The cutting edge of the knife is next to be turned in front, and the point passed through the iris into the anterior chamber; the operator now, pressing with the edge from behind forwards, divides the iris transversely as he withdraws the instrument. The incision should be nearly a quarter of an inch long. The iris gapes, forming an oblong pupil, with its greater diameter in the direction of the cut. In Cheselden's first operation the division was made above the transverse diameter of the iris—the second a little below it; both appear to have been equally successful.

2. *Process of Sharp and Sir W. Adams.* (Pl. XLIX. fig. 6.)—This process is precisely the same as that of Cheselden, with the exception that the iris knife invented by Adams, is entered—with its edge looking backwards—through the sclerotica about a line behind the iris, and carried across the anterior chamber, after being made to penetrate through the iris from behind forwards, a little less than one-third of its width from its ciliary margin, and in its horizontal diameter. The division of the iris to about one-third part of its diameter, is to be delicately made from before backwards by one or more strokes with the knife, for fear of detaching it from the ciliary ligament. The division of the iris in this way, as has been observed by Mr. Lawrence, is not, however, always easily effected. If the lens has been lost, there is a want of resistance, and the iris gives backwards before the edge of the knife, in the direction of the vitreous humour. If the iris be thickened and hardened by disease, it is questionable if its division with this instrument would be practicable without the employment of such force as would detach it from the ciliary margin—or, if made, that the opening would not speedily close again by adhesive inflammation. But if it be found in a healthy condition,

a good-sized pupil may be obtained by this process. When the closure of the pupil is complicated with cataract, Sir W. Adams recommends that the capsule and lens should be freely divided with the iris knife, the larger portion of the fragments brought into the anterior chamber, and the remainder left between the edges of the divided iris so as to prevent their uniting by the first intention—a measure little likely to be attended with benefit, for if the fragment thus interposed was quickly absorbed, it would fail to effect the object; and if not absorbed, it would be likely to excite inflammation of the divided iris.

3. *Process of Janin.* (Pl. XLIX. fig. 7.)—Two important modifications characterized the method of this surgeon. A previous opening was made in the cornea, and the iris divided vertically.

Incision of the cornea.—A puncture through the lower half of the cornea is made with the cataract knife of Wenzel, as in the operation for extraction.

Section of the iris.—A pair of fine curved scissors, with one sharp and one probe point, is then introduced flat into the anterior chamber and carefully opened. The sharp point pierces the iris at its lower border, and is carried up vertically behind it till the end of the other blade comes in contact with the junction of the cornea and sclerotic coat. By closing the blades a vertical section of the iris is made at a single cut. In some of the cases of Janin, a cataract which existed at the time was extracted through the new pupil.

Process of Maunoir. (Pl. XLIX. fig. 8.)—In this process, which is but an improvement on that of Janin, the section of the cornea is limited to a third or a fourth of its circumference. Instead of a single, there is a double incision made in the iris, with a pair of angular scissors, pointed like those of Janin; the two incisions meeting so as to form a Δ , the point of which corresponds with the centre of the pupil, and the base to the circumference of the cornea. By this double section, the radiating fibres of the iris, according to Maunoir, are twice divided. The triangular flap thus separated, has been known to retract suddenly toward the circumference of the cornea, leaving at the moment a free opening for the passage of light. In the course of a few days, the apex of the triangle is usually found widened, so as to form an orifice of a quadrangular shape by the side of the old pupil.

Process of Velpeau.—This is but the first step of the process of Wenzel, described further on. By means of a small, narrow-pointed, double-edged knife, shaped like the lancet known as the serpent-tongued, he penetrates the cornea as in the operation for cataract by extraction. When the knife has entered the anterior chamber, he directs the point backwards *through the iris* into the posterior chamber. The point, after passing for two or three lines along the posterior surface of the iris, is again brought into the anterior chamber. The course of the knife is now continued on till it punctures the cornea on the opposite side, and makes a sort of rounded incision of the fold of the iris which has been raised on the knife—leaving the little flap cut from the iris holding by a narrow pedicle. This flap afterwards rolls upon itself so as to leave a gap for the pupil. With the same instrument, it would be possible to completely detach the flap, so as to convert this process by incision into one for excision.

Second method.

Excision. Corectomia—Iridectomy.—This method, devised by Wenzel in 1780, has been variously modified by different surgeons.

Process of Wenzel.—This process consists in the division of the cornea and iris, with the cataract knife, as in the process of Velpeau. Wenzel opened the cornea to the same extent as in his method for extraction. He then raised the cornea, seized the loosened flap of the iris with a pair of forceps, and detached it at its base with a pair of small probe-pointed scissors, so as to obtain a circular opening.

Process of Physick.—After the opening of the cornea, Dr. Physick proposed to remove a circular piece from the iris with a pair of sharp punch forceps, though I am not aware that the suggestion has ever been carried into practice.

Process of Guerin.—This surgeon opened the cornea in the manner of Wenzel, and made with the keratome a vertical and transverse section of the iris, so as to form four small flaps. But as these do not separate to form a pupil, it has been found necessary in addition to excise the angles of the flaps with the scissors of Maunoir. This process has but little to recommend it.

Process of Gibson, of Manchester. (Pl. XLIX. fig. 9.)—A puncture of the cornea to the extent of three lines is made with the cataract knife at the usual place for extraction. The knife is then withdrawn, and when the aqueous humour escapes, a fold of the iris falls over the incision and closes it like a valve. By light pressure on the upper and internal part of the ball, this fold is made to protrude between the lips of the wound in the cornea, in the form of a little bag the size of a pin's head. With a pair of small forceps, the projecting portion is to be raised, drawn out further if it has not sufficiently protruded, and excised with a pair of small scissors curved on the flat. All pressure being removed from the ball, the iris recedes, and the portion removed leaves an artificial pupil, more or less circular, situated near the sclerotic margin. If, in consequence of posterior adhesions, the iris does not prolapse, it is to be drawn outwards with the delicate hook of Beer, introduced through the wound. If there are anterior adhesions, they should be divided with the cataract knife at the time the puncture of the cornea is made. This is an ingenious and apparently simple method; but the opening is near the outer margin, and unaccompanied by a division of the pupillary border of the iris, without which, according to my own experience, the new pupil formed by either of the processes for incision or excision, will have a strong tendency to close. I would therefore recommend, in all cases after the removal of the circular portion and the recession of the iris, that a probe-pointed needle, cutting on one edge, should be introduced through the new opening behind the iris, and the edge then turned forward so as to divide this membrane as far as the site of the old pupil. I have employed this modification of Gibson's operation in one instance with complete success.

The *process of Beer* differs but little from that of Gibson, with the exception that he makes the opening in the cornea only to half the extent directed by the latter surgeon, and always employs the hook to draw the iris outward. The process of *Walther* is nearly the same as that of Beer. The opening which he

makes in the cornea is intermediate in size to that of Beer and Gibson.

Third method.

Detachment or separation of the iris at its outer margin. Core-dialysis—Iridodialysis.—The invention of this method is usually attributed to Scarpa and Schmidt.

Process of Scarpa. (Pl. XLIX. fig. 10.)—The cataract needle of Scarpa is to be passed in through the sclerotic coat as in the usual process for depressing the lens. It is to be directed toward the superior and internal part of the iris; the point is then to be turned forward and passed through the iris so as to appear in the anterior chamber near to, but without coming in contact with, the cornea. The iris is now hooked on the needle, and by pressing gently downwards and outwards, should be detached from the ciliary ligament to the extent of two lines and a half. The needle is then to be carefully loosened and withdrawn. If the lens should be found opaque, it is to be couched before the needle is removed. It has been recommended, however, in all cases, to break up or couch the lens, as it is almost impossible to carry the needle across the eye in this manner, without wounding the lens or its capsule, so as to occasion subsequent cataract.

By the process of Scarpa, it is difficult to detach the iris on the side next the external canthus—the point at which the artificial pupil is required when the cornea is opaque on its inner half. To obviate this inconvenience, Flajani, Himly, Beer and Buehorn, introduced the needle through the cornea—a plan which enabled them, as they assert, just as readily to detach the iris, and diminishes the risk of injuring the capsule or the lens. Besides the objection above urged against this process, and its frequent development of choroidal inflammation so as to impair the function of the retina, the iris is disposed to rise again towards its old attachment, and thus obliterate the newly-formed pupil. For these reasons, Scarpa himself was in the end disposed to think but little favourably of this method. To obviate this tendency of the iris to reascend, Mr. Donegana has proposed to incise the middle of the depressed portion. The iris, however, yields too readily at its place of attachment to the ciliary ligament to admit of its being readily cut with the needle.

Assalini avoided the injury of the lens and capsule by making a small opening of the cornea, introducing a pair of delicate curved forceps (for which a hook might be substituted) through the anterior chamber, and detaching the iris by seizing it near its ciliary border.

The *process of Langenbeck* (Pl. XLIX. fig. 11), is calculated to effect the objects of this method better than either of those above cited. After making a small puncture of the cornea, this surgeon introduces through the anterior chamber a small hook enclosed in a gold tube, with which he pierces the iris at one point of its circumference, detaches it to the proper extent, and draws the top of the loosened portion so as to leave it remaining between the lips of the corneal incision. It soon becomes adherent in its new position, and prevents effectually the rising of the iris so as to close the new opening. M. Lusardi advises for the same proceeding, a cataract needle curved at the point and notched at the base of the curve so as to perform the office of a hook. It has also been advised, after the separation of the iris in this way,

to excise a part of the depressed portion instead of strangulating it in the corneal wound after the manner of Langenbeck. The wound must, however, be made in the cornea, sufficiently near the part of the iris to be strangulated, to prevent the necessity of much traction of this membrane, which might break away at its peripheral attachments.

Fourth Method.

Extension of the natural pupil. (Pl. XLIX. fig. 12.)—This is a process devised by Langenbeck in cases where the pupil is in its natural condition, and the rays of light are intercepted by a central opacity of the cornea. It consists in puncturing the cornea as in the process just described, introducing a hook and drawing one edge of the pupil aside, so as to leave it strangulated in the wound of the elastic cornea, to which it soon becomes firmly connected by adhesive inflammation. By this means a circular orifice of the pupil may be changed into an ellipsoid, and brought under a transparent portion of the cornea. The puncture of the cornea should not be made more than a line and a half or two lines wide at most, as it will otherwise be very difficult to effect the permanent strangulation of the iris. The author has made trial of this process, but is led to believe that there is greater risk of producing inflammation in the anterior chamber by thus strangulating the iris, than by excising the portion protruded and allowing the lips of the corneal incision to come together.

This method has been recently employed by Dr. Hays,* of this city, in a similar condition of the eye, and described under the name of distortion of the pupil.

Mr. Tyrrell employed the following process for changing the position of the pupil, in cases where the central part of the cornea was opaque, or in which the cornea had become so conical that the accurate perception of minute objects was lost. The instruments employed were a broad needle and a fine blunt hook with a long bend. "The patient should be placed as if about undergoing an operation for cataract. The broad needle should then be carefully passed through the cornea, close to its junction with the sclerótica, and at that part of its margin which corresponds to the interval between the depressor and abductor muscles: in passing the needle through the cornea, one flat surface should be parallel to the surface of the iris, and the other, of course, directed forwards—the instrument should be made fairly to penetrate the anterior chamber of the eye; but should be kept quite free of the iris; it should not be passed so far as the pupil. The puncture of the cornea usually admits of the escape of some portion of the aqueous humour; but, if it be carefully made, a very small portion only of the fluid exudes; and it is advantageous to retain such a quantity that the hook may be carried into the anterior chamber without risk of entanglement in the iris.

"The hook should be passed with the bent limb towards the cornea, or forward; and then it should be carried as far as the aperture of the pupil; and, the extremity of the instrument being introduced through the pupillary space, the bent part of the hook should be directed backward, by half rotating the handle of the instrument between the finger and thumb. The pupillary margin of the iris should next be caught by the hook, by pressing the point gently towards the surface of the lens, at the same time

that the instrument is carefully withdrawn. When, however, the bent part of the instrument is withdrawn as far as the opening in the cornea, its passage will be generally impeded, whilst the point is directed backwards, as when catching the margin of the iris: it is then again necessary to half rotate the handle, so as to direct the bent limb forwards; but, in doing this, the instrument must not be allowed to recede from the opening in the cornea, or the iris may slip from the hook. The hook being directed forwards, and still retaining a hold of the pupillary margin of the iris, should then be withdrawn through the corneal puncture, bringing with it part of the iris; and sufficient of the membrane should be drawn through the opening of the cornea, to effect the desired change in the position of the pupillary aperture of the iris.

"The pupil, of course, loses its circular figure, and becomes pear-shaped, and narrowest immediately in connection with the puncture in the cornea.

"The piece of the iris drawn through the opening in the cornea may be cut off by a fine pair of scissors, or left to separate by ulceration. I usually cut it off, as it lessens the after irritation of the organ."

In the several processes described for the extension of the healthy pupil in cases of central opacity of the cornea, the internal structures of the eye are but little exposed to injury, and the result of operations has been so generally successful, that little farther seems to be desired. But as regards the operations for the establishment of a new pupil, where the old has been permanently closed, the case, notwithstanding the multitude of processes devised, is widely different. Every one at all familiar with the surgery of the eye, must know how exceedingly rare is the successful formation of a new pupil with the permanent restoration of vision. It has been thought useful, however, to cite a number of the processes more generally approved of, as cases may occasionally present themselves, in the very varying morbid condition in which the eye is found, to which their application might be proper. Against most of them it might be urged, that the lens or its capsule is either destroyed, or so much exposed to injury as to become cataractous. For this reason, it has been directed by Rognetta, in all cases after the formation of a new pupil, to break, or couch, or extract the lens. But such a proceeding would be liable to produce injurious consequences after the section of so delicate and susceptible an organ as the iris, and it is better to follow the judicious advice of Mr. Lawrence and leave the lens uninjured when it is possible, even if it should be opaque, and trust to getting rid of it subsequently by couching or division.† The cases in which closure of the pupil is conjoined with cataract, form but a small proportion of those requiring this operation. I have found, even on several occasions after death, a large mass of lymph blocking up the pupil, without disease of the lens or its capsule. As a general rule, then, it may be said that the operations which necessarily involve the destruction of the lens are not the most appropriate. The plan of incision of the iris as ordinarily practised, has been generally abandoned, as it has been

* Tyrrell on the Eye, Vol. II. p. 500-2.

† In Europe, the operation for artificial pupil seems to be most frequently required in cases in which the lens has been removed. In this country, the reverse is the case.

* Vide Hays' Lawrence, p. 447.

found that the divided portions of the iris have a tendency to reunite and obliterate the new pupil. It is altogether inappropriate, when the iris appears discoloured, or is found adherent from previous disease, as the edges of the incision will not then retract so as to form an opening. Of all the modifications of this method, the process of Maunoir appears to be entitled to the most favourable consideration. The method of excision, though it exposes the eye to many of the dangers attendant on the operation for cataract by extraction, has nevertheless been preferred in a great majority of cases, as it insures better, by the removal of a portion of the iris, the permanency of the opening left. Nothing, however, is more common than to find, after this operation, more or less opacity showing itself in the lens or capsule, or such a mass of lymph deposited in the new pupil, as to render the operation abortive. The detachment of the iris after the manner of Scarpa, is rarely followed with good vision, and, it appears to me, if practised at all, should be wholly limited to cases where the cornea is everywhere opaque, except at some point nearly opposite the outer margin of the iris, when it should be performed after the manner of Donegana.

Having been dissatisfied with the result of the usual methods of forming a new pupil, I resorted a few years ago to the following modification of the process of Maunoir, which I have practised in seven cases with a success that has been highly satisfactory. It is founded upon the anatomical structure of the iris, which by a great number of anatomists and surgeons,* has been believed, since the days of Monro, partly from microscopical inspection, and partly from the results of operations upon it, to be muscular. It was the opinion of Monro, that there was one set of circular fibres immediately surrounding its lesser margin, which, by their contraction, closed the pupil; while another set existed in the form of radiating fibres, and were extended across the face of the iris, from its inner to its ciliary or outer border. The blood-vessels form two circles, one around the inner, and one around the outer margin of the iris, and between these, communicating vessels pass across; but the last, as well as those of the inner circle, are so small in the healthy state as to give rise to no hemorrhage when divided in the operation; the vessels of the outer circle are larger, and when cut with the knife, or detached with the needle as in the manner of Scarpa, usually bleed.

Process of the author. (Pl. XLIX. figs. 13, 14, 15.)—The object of this process is to get a good-sized aperture in the iris without injuring in the least the lens, the capsule, or the outer attachment of the iris.

This is accomplished, first, by dividing the radiating fibres of the iris near their ciliary margin, by a crescentic incision made at the same time with the puncture of the cornea; and secondly, by extending another cut from the middle of the incision of the iris to the centre of the old pupil, dividing not only the iris but the new membrane which has closed the pupillary orifice. These incisions will have this shape —. The first one is made with the extraction knife of Wenzel.

* There are some who hold a different opinion in reference to the structure of the iris, believing it to be merely erectile. But the chemical analysis of this organ, the microscopical investigations of Valentin and Henle, and the results of operations upon it, render it pretty manifest that the motions of the iris depend upon a set of circular fibres near the pupil, and a series of longitudinal ones which radiate towards its outer margin.

The patient is to be seated in a chair and in a good light, as described at page 201. The upper lid is raised by an assistant. The surgeon, seated in front, depresses the inferior lid, and taking the knife in his other hand, enters the point *through the cornea at the usual place for extraction*; as soon as it is seen in the anterior chamber, the point, by bringing the handle forwards, is directed obliquely backwards upon the iris, so as to pierce it about half a line from its ciliary margin—for at this place the thin edge of the lens is so far removed from the iris as to prevent its being wounded. As soon as the puncture of the iris is made, the handle is carried backward so as to bulge the iris a little forward with the point; the knife is then carried on, dividing the iris and cornea till the point of the instrument is advanced half-way between the place of puncture of the iris and the closed pupil. The knife is then to be carefully withdrawn. If this step of the operation be neatly executed, none of the aqueous humour will escape till after the removal of the knife, and then but in a very small quantity. The incision of the cornea should be about a fifth of its circumference, that of the iris will have a shape concentric with its outer margin.

The delicate probe-pointed scissors of Maunoir are then to be inserted, closed, flatwise through the lips of the corneal wound. As soon as they have entered the anterior chamber the blades are to be slightly opened, and the handles turned so as to look obliquely downwards and forwards, in order that the blade next the cornea may not injure this structure. One blade is to be carried through the puncture of the iris, behind that membrane, and the other in front, as far at least as the centre of the old pupil; the handles are then brought directly horizontal, and the second incision made by closing the scissors. If the iris is healthy and unadherent, the operation is now completed. Not a drop of blood will have escaped. A beautiful artificial pupil will be at once formed. The base of the radiating fibres belonging to the outer part of the iris having been cut, the pupillary circular fibres—which are divided in their middle—having now no resistance, contract and draw upon the two loosened triangles of the iris, so as to bring their edges into a straight line, and make the new pupil widest at the central position. The shape of the pupil will be such as seen at Pl. XLIX. fig. 15. Immediate vision will be restored if the retina is in a healthy condition. The eye, however, is to be closed, and treated for a few days as after extraction, with the exception that the temples and margin of the orbit should be covered with the extract of belladonna to keep the iris dilated as widely as possible.

Process of the author in case the iris should be found adherent to the centre of the capsule, or so altered by disease as to have lost its contractility.—The operation is to be conducted in most respects as that just described; but the chance of a successful result is much diminished. The chief difficulty likely to be encountered will be in the resistance of the adhesion to the passage of the blade of the scissors behind the iris. I have operated in two instances where these adhesions existed, but in both they were found so slight that they gave way on turning the scissors to make the section, which should always be done so as to bring the iris a little forward, and keep the instrument from pressing, or if possible, touching the lens. If, however, the adhesion does not readily yield, the separation and division of the iris may be effected

by the delicate probe-pointed needle-knife, shown at fig. 17, which I have employed advantageously for this purpose by introducing it flatwise behind the iris, and then turning the edge forward so as to make the section. The margin not contracting at the moment of incision, the aqueous fluid that flows out on the withdrawal of the scissors, brings with it the two corners of the —) like division of the iris. The angles of these are to be laid hold of with a delicate pair of forceps, drawn out at the corneal wound so far as they will readily yield, and snipped off with a pair of curved scissors. The iris then recedes from the wound and a pupil will be formed, with its broadest end on the side next the corneal incision, the circular pupillary fibres acting, in such cases, if at all, to much less extent than when the iris is healthy. A very excellent pupil may, however, in this way be formed.

Remarks.—The iris, when its organic structure has been much changed, I have found occasionally to throw out blood; this, if in small quantity, appears to be soon absorbed from the aqueous chamber, and without injurious consequences. In one of the seven cases in which I have operated there was an effusion of blood, so as to fill a third of the anterior chamber; but the pupil after its absorption remained beautifully clear and open; the degree of vision restored, however, was not perfect, as the patient had suffered from syphilitic iritis, which had rendered the ball of the opposite side deformed. In another case I found the iris so changed in structure, and so firmly adherent to the capsule, that but a small pupil could be made, which subsequently in a great measure closed up. A third case was one of opacity of the inner two-thirds of the circumference of the cornea, with anterior adhesion of the iris near the centre of the opacity, leaving the patient so blind as to be unable to go about without a conductor. The puncture of the cornea was here made in part through the opaque portion, and a good-sized pupil formed opposite the clear part of this membrane. The restoration to vision seemed nearly perfect. On the seventh day after the operation the patient was so unwise as to walk for a mile and a half, exposed to an October sun, and suffered afterwards from iritis, which had the effect of diminishing the size of the new pupil; he still, however, retains a sufficient degree of vision to obtain a living as a sort of itinerant merchant. In the four other cases the success was perfect, with the exception that in one the posterior synechia had left a speck in the centre of the capsule. In this case I operated on both eyes, the pupil of each having been closed by syphilitic iritis, so as to leave the patient barely able to distinguish the windows of her room. So little irritation was occasioned by the first operation, that on the second day afterwards she threaded a fine needle and was found sewing. In the second eye, which was operated on three weeks subsequently, there was some posterior adhesion of the iris; slight pain, and the effusion of a few drops of blood attended the operation, but the success was ultimately perfect. All of these operations were, with the exception of two, performed before the class of the Philadelphia Hospital.

STAPHYLOMA CORNEÆ.

In this affection the cornea is altered in its structure, unusually protuberant, and most commonly adherent to the iris by the intermedium of lymphatic exudation, which has become organized.

The staphyloma may be total or partial, according to the extent of cornea involved, and either spherical or conical as respects its form. The thickening and loosening of its tissue from inflammation to such an extent as to bring it into contact with the iris—and penetrating ulcers through which a prolapse of the iris has taken place, are the common causes of this affection. If the aqueous secretion goes on in the posterior chamber of the eye, while the function of reabsorption is but imperfectly executed, the cornea, even when previously thickened, begins to protrude in consequence of the pressure behind, and gradually becomes thinned so as to form a tumour more or less prominent between the lids, which are kept by it in a constant state of irritation. Partial staphyloma occurs most frequently on the lower part of the cornea, and may be usually arrested in its progress by proper medical treatment, and the occasional puncture of the prominence with the lancet, to allow the escape of the redundant fluid. If, however, it attain a size so great, whether it involve the whole cornea or not, as to be unsightly and interfere with the movements of the lids, an operation for its removal may be resorted to with advantage. It is well, however, to let considerable time elapse after the development of a corneal staphyloma before proceeding to its excision, for it is possible that the tumour may be caused to subside by a general atrophy of the bulb, an instance of which, when the staphylomatous prominence was very great, the consequence of ill-treated gonorrhœal ophthalmia, has come under the notice of the author.

The following is the process for excision ordinarily recommended:—The patient is to be placed as in the operation for cataract; an assistant supports the head against his chest, raises the upper eyelid with one hand, and depresses the lower with the other. The operator takes hold of the point of the tumour with a pair of sharp hooked forceps, and passes a cataract knife so as to divide one-half of its base, as in the operation for extraction. The upper half of the flap may then be detached with the curved scissors, or by a re-application of the extraction-knife; but in the use of the latter care must be taken not to injure the margin of the tarsus. As soon as the excision is completed, the assistant relaxes the lids, which for a few days are to be kept closed. Simple as this operation appears, great care is required on the part of the assistant to relax the lids at the proper moment, in order to prevent the escape of the lens and vitreous humour. If the patient be restless, or there is a rolling motion of the eye, Von Ammon prefers to make the first incision upwards, and completes it by a downward section with the scissors, so as to render the lens and vitreous body less liable to prolapse, the loss of which, however, is unavoidable, if a conical staphyloma is extirpated at its base. The chief accident attendant upon this operation, is profuse bleeding from the morbidly enlarged vessels of the cut surface, or from those of the choroid coat. The former is usually of little moment, as it may be stopped by the use of cold lotions; the other, which arises as a consequence of a prolapsus of the retina and choroid in the shape of a bladder after the loss of the vitreous humour, is usually profuse, and accompanied with violent pain. The safest remedy in this case is the excision of the bladder with a pair of scissors, and the application of cold. Pain, even to fainting, may be produced by a violent pull upon the flaps of the cornea. If the lens and vitreous body are both discharged, the bulb will

collapse; if a part only be lost, an artificial eye may still be inserted afterwards. After the operation, the eyelids are to be carefully dried and closed with a strip of adhesive plaster, so as to keep them at rest. Both eyes are to be covered in addition with a compress, and the patient put to bed in a darkened room. After six or eight days the eye may be opened; the wound will then be found closed by a grayish membrane, through which the patient may be able to perceive large objects. This membrane afterwards becomes thickened, forming a flat streaked cicatrix. When all the irritation has been removed, an artificial eye may be inserted.

This operation is one of serious import, and Scarpa particularly recommended as being less dangerous and violent, the excision of a round piece two or three lines in diameter from the centre of the tumour. M. Bonafons* modified this process by taking out a portion by two parallel cuts.

I performed the following operation at the Philadelphia Hospital, in two bad cases of staphyloma, with the desired effect of reducing the tumour to its natural dimensions, removing the cause of the irritation of the lids, and without producing atrophy of the ball. In one of these cases I removed a membranous cataract which was exposed to view during the operation, with the effect of restoring a considerable degree of vision; this was, however, subsequently lost when the cicatrization of the corneal fissure, which was for some time kept transparent by the prolapsus of a small portion of the vitreous humour, became complete, so as to bring the opaque surfaces of the cornea together.

The operation (Pl. XLIX. fig. 16) consists—after placing the patient as just described for the excision of the mass of the tumour—in making two elliptical and vertical incisions through one margin of the cornea, selecting the part which is opaque, and leaving any transparent portion that may exist, in the hope of rendering it useful for the purpose of vision. The incisions should be made with a delicate and sharp-pointed knife, and carried at the lower part through into the aqueous chamber. Through this opening the aqueous humour will escape; the edge of the piece loosened at this point is then to be raised with a cataract hook, and the circumscribed elliptical portion cut out with a pair of delicate scissors. The piece removed will consist usually not only of the cornea, but of the thickened and adherent iris. The eyelids are then to be closed, as in the ordinary operation. The piece removed must vary in breadth according to the prominence of the cornea. It does not, however, seem necessary—judging at least from these two cases—that it should be of a size calculated to bring the cornea at once down to its proper dimensions, as the effect of the incision into the aqueous chamber is to diminish the tendency to the excessive reproduction of the aqueous humour.

STAPHYLOMA SCLEROTICA.

The pathology and etiology of the soft and dark-coloured staphylomatous tumours, which project through the thinned portions of the sclerotic coat, are in many respects analogous to the affection last described. These tumours require to be treated by puncture and excision, like those of the cornea. An adhesion in this case takes place between the sclerotic and choroid coats, as in the former between the cornea and iris.

* Journal des Connaissances Méd. Chirurg., 1837.

STRABISMUS.

Since the introduction of tenotomy for the purpose of aiding in the cure of various deformities arising from the contraction or shortening of the muscles about the joints, it has been well ascertained that the affection commonly known under the name of cross-sightedness or squinting, is in a vast majority of cases dependent upon a similar affection of one or more of the muscles of the eye. The notorious ill success of all the methods formerly proposed for the relief of strabismus, induced the profession to embrace with ardour the new plan of cure by division of the tendon of the muscle at fault—a proposition which was suggested by Stromeyer, of Hanover, in 1838, and carried into practice two years after by Professor Dieffenbach, of Berlin. The immediate success obtained by this surgeon caused the experiment to be repeated by operators of all classes and descriptions, and cases were multiplied with a rapidity of which no other branch of surgery can show an example. Without pausing to watch attentively the results of these operations, or study minutely the very peculiar structure or functions of the parts concerned, many individuals hurried on to add to their list of cases, and to the invention of a multitude of specific hooks, knives, forceps, and specula; as if the operation was ridiculously easy, and presented a field for the exercise of instrumental legerdemain. A few months' experience, however, served to show, that the operation for the cure of squinting, to be done well, required much more knowledge of the parts concerned, much more judgment in properly proportioning the extent of the section to the peculiarity of the case and the age of the patient, and much more dexterity and precision, than was at first supposed. But this discovery was not made until the high-wrought expectations of the public had been in a measure disappointed with the results produced, or disgusted with the charlatanry which it brought into notice; and many individuals have been inclined to look with disfavour on a most ingenious operation, which, when properly performed, may be considered one of the most successful in surgery; removing, as it does, at a trifling cost of suffering, an affection which is not alone deforming, but apt to lead in the end to an impairment of the visual power of the affected eye. The operation in truth forms but a part of a more extended process of cure, removing the most prominent cause of the defect, and giving a favourable opportunity to the institution of a sort of gymnastic exercise of the other muscles of the eye, susceptible of being aided by mechanical contrivances analogous in their principles of action to the orthopedic machinery for the cure of contracted muscles, without the use of which tenotomy is in general found unavailing.

For the correct institution of this exercise of the muscles, a thorough knowledge will be needed of the immediate causes of the deformity, which are found so complicated and various that almost every new case becomes an especial object of study; but as the investigation of these would lead far beyond the proportionate limits to which the subject must here be restricted, the author is obliged to refer the reader for further information to some of the various treatises written upon the subject.

Surgical anatomy.—There are six muscles attached to the eyeball, four of which are straight, and two oblique. The bellies of these muscles are all enveloped in capsular sheaths, which spread out near the anterior termination of the muscles, so as to be con-

tinuous upon their sides with one another, and form a membrane called the intermuscular aponeurosis, which embraces the posterior two-thirds of the ball, and runs forward to be inserted circularly with the tendons of the straight muscles upon the sclerotic coat. From this place of insertion a thick cellular layer is reflected off on the posterior surface of the ocular conjunctiva, forming what has been called the subconjunctival fascia. This fascia ultimately splits into two processes—one of which is attached to the periosteum of the orbit, and the other to the tarsal cartilages on the outer surface of the palpebral conjunctiva. From the ocular surface of the intermuscular fascia, a thin layer is reflected off so as to surround the posterior two-thirds of the sclerotic coat, and get an attachment behind to the theca of the optic nerve, forming a sort of cup or socket in which the ball of the eye plays. Between this and the intermuscular fascia is a sort of triangular interval, filled out with fatty cellular tissue. Through the conjunctiva, and through the conjunctival fascia, we must cut to reach the tendons of the muscles, which will then be found with the intermuscular fascia or aponeurosis spread between them. This is necessarily opened in the division of the tendon, and inasmuch as it often in long-standing cases shares in the contraction of the muscles to which it is closely attached, it will frequently require to be dilated in the direction of one of the adjoining muscles. In a case of fixed internal squint of long standing, I have found the intermuscular and sclerotic fascia so thickened and adherent as to hold the eye immovable after the division of the muscle, and require to be dissected away from over a considerable part of the inner surface of the ball, *before* the eye could be rendered straight.

The straight muscles are opposed in pairs at the two extremities of the transverse and vertical diameters of the eye, and form together a sort of pyramid, the base of which is attached to the globe of the eye, and the point to the apex of the orbit. Their tendons of insertion are three or four lines long, and as much broad, and wind round the bulging portion of the ball to be inserted on the sclerotic coat about three lines behind the cornea. The eye is placed completely under the influence of these muscles, which act upon it like so many cords, and serve in conjunction with the intermuscular and conjunctival fasciæ, as the principal stays which hold it from protruding in the orbit, and sink it inwards so as to maintain a solid support for the ball in cases of emaciation. When one of these muscles acts, the ball rolls in that direction, and the antagonist muscle, which is necessarily at the same time relaxed, is partially wound upon the ball. As the eyes are naturally destined to converge to the same point, the internal rectus is the shortest of the four, and the external rectus the longest. When any two of the adjoining straight muscles act with equal energy, the ball moves in the diagonal between them. And when one muscle acts with its greatest force, it is usually assisted by the two adjoining muscles.

Oblique muscles.—The superior oblique is the longest of the muscles of the eye. Its tendon passes through a trochlea at the inner part of the upper brim of the orbit, is reflected back at an angle of 45 degrees, insinuates itself under the superior rectus, and is inserted on the middle of the sclerotic coat on a level with the transverse diameter of the eye. The *small* or *inferior* oblique arises from near the anterior and internal part of

the orbital plate of the malar bone, and passes diagonally across the under surface of the globe, to be inserted on the middle of the external part of the sclerotic coat. The course of these two tendons over the globe is nearly on the same plane, and they act as the antagonists to each other in rolling the ball upon an axis peculiar to themselves.

Between the ball of the eye and the sloping surface of the bones at the internal canthus, there is a space much larger than that found at the outer canthus. In this space are lodged the lachrymal organs and a mass of adipose and cellular tissue intended for their protection, partly covered by the plica semilunaris, to the outer side of which lays the internal rectus muscle. With this space the operator should be well acquainted, and cautiously guard against opening it with the scissors or pinching it with the forceps. An incision here would not only serve to embarrass the young operator, and endanger the integrity of the lachrymal sac, but be likely to give rise in addition to inflammatory swelling, and leave the cellular tissue, even after the cure, in such a hardened condition, as to serve as a new cause for the reproduction of the deformity. Under no circumstances should it be opened. It is easy enough to avoid it in ordinary cases, but great care will be required for this object when the eye is turned strongly in, and cannot be everted so as to expose the entire cornea, several instances of which I have encountered in the course of my practice.

Forms of Strabismus.

There are four principal varieties of strabismus, founded on the direction of the eye affected.

1. *Strabismus convergens.* (Internal, nasal or convergent strabismus.) This forms a vast proportion, that of twenty-eight to one, according to Baudens, of all the cases presented, and is dependent on the retraction of the internal rectus muscle.

2. *Strabismus divergens,* (external, temporal or divergent strabismus,) dependent on the action of the external rectus.

3. *Strabismus sursum vergens,* (superior or frontal strabismus,) produced by the excessive traction of the superior rectus.

4. *Strabismus deorsum vergens,* (inferior or jugal strabismus,) dependent upon the action of the inferior rectus.

Neither of the last two varieties commonly occurs, except as the consequence of injury, or local disease involving the muscles or nerves.

In either of these varieties, the strabismus may be limited to one eye alone, or it may be double. The latter is by far the most common, especially in relation to convergent strabismus, though the distortion commonly varies as to degree between the two eyes.

Another variety of strabismus has been a few times observed, (*strabismus horrendus*,) where the deformity is produced by the opposition of the moving forces of the two eyes, one eye being carried outward and the other inward, or one upwards and the other downwards.

Each of the four principal varieties may exist in different degrees, from a slight and barely appreciable obliquity, called by Buffon "a false trait of vision," (and which seldom or never justifies an operation,) to such an extreme degree of distortion, that the cornea is hid in one of the canthi or under the margins of one of the lids.

Complicated or mixed strabismus.—Around the four principal types of the affection may be ranged the complex or mixed varieties, which form a very considerable proportion of the cases met with in practice. When we consider that the eye can be turned in the direction of all the radii of the circle in which it moves, by a combination of two or three of the adjoining straight muscles, a mixed form of squint is what we should expect very likely to happen. And if we moreover reflect, that the muscles are not inserted by a point, but by a band of tendon three to four lines broad, it appears equally plain, that if with a spasmodic contraction of the internal rectus muscle, there should also be a shortening of the inner border of the superior rectus, the deformity produced would be in a direction inwards and upwards; and inwards and downwards if the association be between the internal rectus and the inner border of the inferior rectus. The same kind of combination between the external rectus and the superior and inferior may produce a squint, in the direction outwards and upwards, or outwards and downwards. These are often, especially in children, the primitive forms of the affection. They frequently occur also as a secondary result, when, from the eye being almost habitually held in one direction, the edge of the adjoining muscle shortens itself, or rather loses a portion of its natural extensibility, so as to accommodate itself to the altered relation of parts. The inward and upward squint is by far the most common of all these mixed forms. Its greater frequency has been attributed to the assistant action of the oblique muscles; but this opinion, I am satisfied, is an error, both from a most careful examination of the simple and combined action of the muscles of the eye on the dead body, as well as by the division of the superior and inferior oblique, several times upon the living, an operation which has never appeared to me in the least to influence the position of the ball. It is, I am satisfied, in the

action of the recti alone, single or combined, that we are to look for the immediate cause of the deformity either in simple or mixed strabismus.

The *condition of the muscle* affected in strabismus is not, in the generality of cases, strictly analogous to that in club foot, as it is but rarely found to have undergone a fibrous degeneration. It is dependent mostly upon a relative increase of power over its antagonist muscle, or a sort of spasmodic shortening which, while it draws the ball unusually far on the side of the deformity, does not completely fix it there, but yields more or less to the action of its antagonist, though it falls again into contraction before it is drawn out to the natural extent—acting precisely as if the muscle was too short or too powerful, and as though disadvantageous action might be remedied by dividing it at its place of insertion, and allowing it to become reattached further back upon the ball. This is moreover the object proposed in the usual plan of operation.

When it has undergone the *true fibrous degeneration*, so as to be converted into a mass of more or less shortened and unyielding tissue—cases of which are occasionally met with—the eye is fixed in its deformed position, so as to be but to a limited degree movable. If the degeneration is complete, the eye is thoroughly fixed; and this deformity, when it takes place as it usually does at the internal canthus, has received the name of *lucitas*.

Occasionally the deformity of the eye is purely spasmodic or intermittent, the consequence of mental excitement or gastric irritation. This variety rarely justifies the operation.

Sometimes we notice an alternate spasm of the two antagonizing muscles, so as to keep the eye steadily moving inwards and outwards, and greatly to interfere with vision. This is denominated *nystagmus bulbi*, and has been treated by Dieffenbach by

PLATE L.—STRABISMUS.

DIVISION OF THE INTERNAL RECTUS OF THE RIGHT EYE. (*Process of the Author.*)

- Fig. 1.*—*Division of the mucous membrane and the subconjunctival fascia in order to expose the tendon.*—The head having been supported as directed in the text, and the other eye closed with the hand of an assistant, or with a compress and ribbon, the spring speculum is applied upon the cutaneous surface of the lids, so as to hold them asunder and fully expose the ball. In the drawing, the eye not operated on is left uncovered to show the manner in which the forceful traction of the squinting eye outwards causes the other to diverge likewise in the outward direction. The surgeon then enters a double hook about two lines and a half at the inner side of the cornea so as to steady the ball, and turn it slightly outwards, while he raises with the lower point of the scissors a fold of the membrane over the tendon, which he divides with one or more strokes of the instrument, so as to expose the tendon just behind its place of insertion.
- Fig. 2.*—*Elevation of the muscle on the blunt hook.*—Without changing the hold of the sharp double hook, the blunt hook is passed round the muscle, as seen in the drawing. The operator has now the command of the eye with the latter instrument, and the sharp hook may be removed.
- Fig. 3.*—*Division of the tendon.*—The operator holds the eye with the blunt hook, and reverses the scissors so as to pass the other point which should be blunted underneath the tendon which he divides across.
- Fig. 4.*—*Division of the intermuscular fascia.*—In case this is found shortened so as to present an obstacle to the eye becoming straight, it is to be raised with the blunt hook and divided to the requisite extent with the scissors, but most cautiously, for fear that by dividing it too freely the eye may be made to protrude from the socket, or turn in the opposite direction.
- Fig. 5.*—Speculum, or eyelid elevator of Pellier.

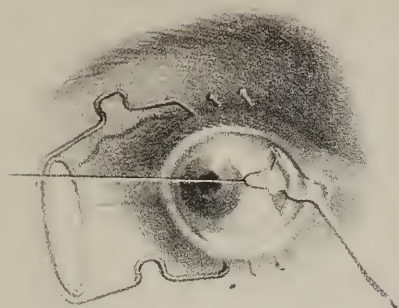


Fig. 2.

Fig. 3.



Fig. 1.



Fig. 5.

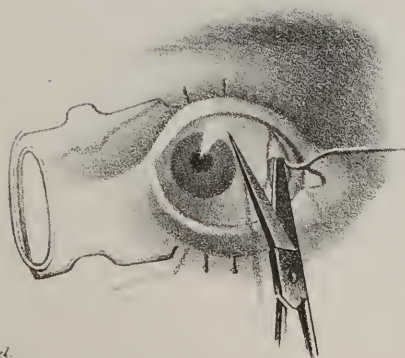


Fig. 4.

the simultaneous division of the tendons of the two muscles at fault.

Operation.—The operation for the division of the tendons of the different straight muscles, I find perfectly easy by the processes given for the internal rectus, the one most usually the subject of operation. The operation upon the internal is, therefore, the only one that will need description here. There are two distinct methods of operation—in one, that most commonly employed, a division of the tendon is made, after having laid it bare by a section through the conjunctiva; in the other, which has been introduced by M. Guérin, and called the sub-conjunctival method, the muscle is divided below the conjunctiva by a mere puncture through that membrane.

1. *Operation by the usual method.*

The processes peculiar to this method are very numerous; and as they are essentially very nearly the same, it will be necessary to notice only a few, and these but briefly. The position for the patient preferred by almost every operator, is that of the sitting posture, the head being supported as in the operation for cataract. The operator should be seated on a chair higher than that of the patient, or, if he prefers, he may operate in the standing position.

Process of Dieffenbach.—This surgeon causes the eyelids to be separated with a Pellier's speculum applied to each. A fold of conjunctiva is then raised with a couple of sharp hooks near the place where the conjunctiva meets the ball; between the hooks the fold is divided vertically with a pair of scissors, so as to expose the tendon. The tendon is next to be raised with a blunt hook, and the muscle divided with the scissors on a flat probe, either near the place of its tendinous insertion on the sclerotic coat or farther back through the anterior part of the belly. In some of the instances, in which the front part of the belly of the muscle was divided, he snipped off the anterior portion from the sclerotic coat, in order to prevent the reunion of the divided ends of the muscle, and guard against a reproduction of the deformity.

But the division of the belly of the muscle and the excision of any part of it have both been abandoned, inasmuch as they have been found to destroy the action of the muscle, which by other means can be preserved. The removal, moreover, of any part of the structure at the internal canthus, so as to cause a depression in that region, allows the caruncula lachrymalis and plica semilunaris to fall back and leave an obvious deformity which it is very difficult to correct.

The *process of Ammon* is nearly the same as that of Dieffenbach. He, however, raises the conjunctiva with a pair of forceps, and divides the fold with a knife as well as the tendon after having raised the latter on a grooved and curved probe.

Velpeau has the lids separated as described above, or with a self-acting dilator (blephareirgon), and applies two hooked forceps upon the conjunctiva—one of which—that next the reflection of the conjunctiva from the ball to the lid, grasps at the same time the muscle and the membrane. With a pair of blunt-pointed scissors he then divides the conjunctival fold, as well as the portion of the muscle included in it. He next examines with the blunt hook to see whether there is any portion of the muscle left undivided, to require the further use of the scissors.

Baudens raises the muscle with a pair of forceps, and inserts between it and the ball a small sickle-shaped bistoury, curved likewise on the flat, so as to open the conjunctiva and fascia on either side of the tendon. A small hook is then introduced below the tendon, and the division completed with one stroke of the scissors.

Process of Liston.—One assistant holds the head of the patient, and raises at the same time the upper lid with the speculum of Pellier. The operator depresses the lower lid with one of the fingers of his left hand, and attaches a pair of flat-toothed spring forceps on a fold of the conjunctiva at the point at which this membrane is reflected from the ball to the lid. The forceps are left pendant, and by their weight serve to keep the lower lid depressed. A small double hook is fixed into the conjunctiva on the inner side of the cornea, by which the assistant draws the eye outwards. The operator now seizes the conjunctiva close to the caruncle with the common forceps, and divides it freely with a pair of strong and pointed scissors. Another hook is placed in the sclerotic coat, which is now exposed, and the first hook removed. The tendon of the internal rectus is then laid hold of with the forceps and divided with the scissors, and the whole inner surface of the ball cleared of the tissue inserted upon it.

The author has tried the different plans proposed for the performance of this operation, and is free to admit, that they can all be made to answer the object desired. He has even found it perfectly easy with a pair of good rat-toothed forceps to raise the conjunctiva, fascia and muscle, in a single fold, and divide them all at once by a single stroke with the scissors;—but, however, except as regards its celerity of execution, which is a matter of but trifling importance, there is nothing to recommend the plan. He relies now upon the following process, which he has employed in about four hundred cases, a considerable portion of which having been operated on in public, and has no hesitation in recommending it to the favourable notice of the reader, as one combining the greatest ease, precision, and, *if judiciously practised*, almost infallible success.

Process of the Author. (Pl. L. figs. 1, 2, 3, 4.)—The instruments which will be found most convenient, consist of the spring dilator seen applied at fig. 1, an elevator and depressor of the kind seen at fig. 6,—required only in cases to which the spring elevator is not applicable,—a double hook well opened between its prongs, a pair of long, delicate, rat-toothed forceps, a pair of angular scissors, blunted at one of the points, and a blunt hook.

The eye of the other side is to be covered with a compress and ribbon, or by an assistant, who, at the same time that he stands behind so as to support the patient's head, covers the opposite eye with one hand, while he aids in the separation of the lids of the other. By thus closing the eye which is not to be operated upon, the patient instinctively turns the other one towards the middle of the orbit, and in this way facilitates the first steps of the operation. If the patient be young and unmanageable, it may be necessary to lay him in the lap of one assistant, against whose shoulder his head should be held by another, his arms being in addition firmly bound to the sides. But as a general rule, it is best not to operate on patients under seven or eight years of age; for at this period of life and upwards, the desire to get rid of the deformity will induce them, especially if

inspired with confidence by the tact and kindness of the surgeon, to submit cheerfully to the operation, provided it be done, as it may be, quickly and almost without pain. The operation, for the purpose of description, may be divided into four stages: 1, the separation of the lids; 2, the division of the conjunctiva so as to expose the tendon; 3, the raising and division of the tendon; and, 4, the division or dilatation of the fascia.

Division of the internal rectus of the right eye.—The separation of the lids should be effected with the spring speculum as seen in fig. 1, which usually holds the lids securely, and enables the surgeon at want to operate without an assistant. The instrument should be made to act on the cuticular surface of the lids merely, as its application will then be unattended with pain, and far less likely to excite spasmodic action of the orbicular muscle. But in case the patient be indocile, or spasm of the lids follow so as to unseat the dilator, it will be necessary to introduce the hooks between the lids and the ball; or if the spasm, as now and then happens, be so very violent, as to cause the spring to yield, (which must be made but of a certain degree of stiffness only, so as not to give pain in ordinary cases,) resort must be had to the elevator of Pellier (fig. 5) for the upper lid, and a depressor of a somewhat similar shape for the lower, which, like the spring speculum, it may also occasionally be found necessary to introduce between the lid and ball. It should, however, be remembered, that the use of the instruments in this position occasions infinitely more pain than all the other steps of the operation together. The operator must be prepared to meet with great difference in various cases, as to the facility of separating the lids. So little, in many instances, is the resistance offered, that it will answer to have the lids merely separated with the fingers of an assistant. In this way, I have operated on more than thirty cases without difficulty.

Having the lids separated, and the opposite eye closed, the operator now directs the patient to look outwards, and inserts the double hook, as shown in fig. 1, through the conjunctiva into the fibrous expansion of the tendon, at the distance of two and a half to three lines behind the margin of the cornea. With the hook he has now a perfect command of the eye; but he should not, as has been directed, force the ball strongly outwards, as this would occasion unnecessary pain, and lay the tendon to be divided too flat upon the ball to be easily raised with a blunt hook. It is sufficient to turn the cornea a little beyond the middle of the orbit—steadying it securely in that position. With a pair of angular scissors, slightly opened, and held as seen in the drawing, he next raises a fold of the conjunctiva and subjacent fascia, and divides it at one stroke by closing the blades, so as to expose the tendon. The fold is readily raised by inserting the sharp point of the scissors into the membrane a little below the lower edge of the tendon, and pushing it up before the blade a little higher than the horizontal diameter of the ball. The cellular tissue and intermuscular fascia may next be snipped with the scissors at the upper and lower edge of the tendon, and the wound in the conjunctiva widened if it do not sufficiently expose the parts beneath. A blunt hook, which may for convenience be held in the mouth, should now be passed under the muscle, either from below upwards, which I find most convenient—or from above downwards, as has been recommended by several operators. With this

instrument he has now complete control of the eye, and the sharp hook, which is no longer useful, may be removed. The surgeon now turns the scissors in his hands, introduces the blade with the blunt or probe point below the tendon, as seen in fig. 2, and divides the tendon at one stroke by the side of the hook. All the instruments are now to be removed, and in many instances the operation will be found complete. Little more than the effusion of a few drops of blood takes place, provided the patient does not struggle so as to cause a congestion in the vessels of the part, and the surgeon is careful to cut on the outer side of the plica semilunaris. If blood should flow so as to mask the parts during the operation, it must be removed with a sponge, in order that the surgeon may see clearly what he is about, and avoid all laceration or mangling of the membrane, which is found to interfere with the speedy healing of the wound. After a few moments' repose, the blood which may have again collected is to be carefully sponged away from between the lids, and the position of the eye examined. If it has become straight, the patient will have lost the power to a great degree of turning it in the direction of the previous deformity, and will have regained that of rolling it outwards to the natural extent, so as to hide at least all the outer portion of the adnata. If it has not become straight, it becomes necessary to dilate the fascia—above the place at which the tendon was divided, as will be most frequently required—or below it, in case the squint has been inwards and downwards. This must be accomplished as shown at fig. 4. The lids are to be again separated with the speculum, or with the fingers, and the blunt hook introduced through the flap of the conjunctiva under the fascia, so that the eye may be drawn a little outwards and give room for the division of the fascia to the requisite extent with the scissors, the probe point of which is to be passed below, precisely as in the section of the tendon. In bad cases of the mixed upward and inward squint in persons of middle age, it may be necessary, in addition to divide a part of the insertion of the superior rectus or to sever some of the deep-seated bands of condensed cellular tissue at their place of connection with the inner surface of the ball. This is the stage of the operation which calls for the greatest exercise of judgment on the part of the practitioner. If he divide the parts to the extent proper to each individual case, he will be certain to produce a perfect cure of the deformity. If he divide them too freely, he may have the vexation to see the ball turn sooner or later in the opposite direction, and produce an external squint; and perhaps, by too far loosening the fascia and muscles which serve to stay the ball in the orbit, encounter the still greater misfortune of a protrusion of the organ. And if the section is not carried sufficiently far, the relief of the deformity will not be complete.

In these cases the surgeon must recollect, that provided there has been a double squint, *which may always be told by a careful inspection of the eyes beforehand*, it will not be safe to attempt to cure a deformity more or less common to both eyes by operating upon one—and that in these cases of double squint the whole amount of the distortion in the two eyes may be accumulated in one while the other is turned directly in front, or if neither eye be turned exactly in front, divided between them.

In bad cases of double squint it will usually become necessary to perform a corresponding operation on the other eye, provided

it does not subsequently become straight by a sort of self-adjusting power, which the eyes, when properly exercised after the section of one tendon, unequivocally possess. One advantage attending this double operation, especially if the eyes have appeared in consequence of retraction of the muscles, unduly sunken, will be that of restoring both to the same degree of prominence. In case of doubt as to the propriety of making the section of the fascia at the time of the operation, and especially if there is reason to believe that the external rectus will speedily gain an increase of power after the division of the antagonist, it will be well to defer the section of the fascia for two or three days, when if necessary it may readily be raised and divided without any new incision in the conjunctiva.

Division of the internal rectus of the left eye.—In this operation, the lids are to be separated and the scissors and blunt hook employed precisely as on the right. But as the use of the sharp hook for the purpose of holding the ball outwards, would render it necessary to employ the scissors in the left hand, in which they do not cut well, it will be found advantageous to substitute a pair of rat-toothed forceps for the double hook. With the forceps, a fold of the conjunctiva is to be raised just on the outer side of the plica semilunaris; this fold is then to be divided with the scissors, and the operation continued precisely as on the other eye.

Sub-conjunctival method. (Process of Guérin.)—The method upon which this surgeon mainly relies is the following. The lids are to be separated in the ordinary manner. Two double hooks are employed to raise a fold of the conjunctiva over the ocular extremity of the muscle—one of which is held by an assistant and the other in the left hand of the surgeon. One of these hooks, that nearest the cornea, should take hold of the sclerotic coat, the other must be inserted through the mucous membrane so as to raise the sub-conjunctival fascia below it. The surgeon then passes the perforator, which consists of a small spear-headed knife, through one side of the base of the fold, and between the muscle and the ball; the knife, after being moved a little laterally in order to enlarge the space, is then withdrawn, and through the puncture thus made a small elbowed, blunt-pointed myotome is inserted flatwise so as to get completely between the muscle and the ball. The hook nearest the canthus may now be removed. The surgeon, with the other hook, which is inserted into the sclerotic coat, rolls the ball in the opposite direction so as to make the muscle tense. The myotome, which previous to this movement upon the ball should be turned with its edge upon the muscle, is now by a slight sawing movement made to divide the muscle and a portion of the subjacent fascia across, but without cutting the conjunctival mucous membrane. The division of the muscle is accompanied with a snapping sound, and a sense of yielding of the parts on the same side of the ball.

The object of this operation is to avoid a wound in the conjunctiva. I have several times tried this process with good success, and though it is of sufficiently easy execution, it does not, as it appears to me, possess any peculiar advantage over the one more commonly employed, in which from the parts being more fully exposed to view, the operation can be done with greater precision. It is, moreover, accompanied by an effusion of blood, which, as it cannot readily escape externally, forms a clot below the mem-

brane lining the lower half or two-thirds of the ball of the eye, which is but slowly absorbed.

II. ON THE EAR.

The auricle is sometimes the seat of boils, tumours and cancer, and has been found enlarged by simple hypertrophy, so as to constitute a serious inconvenience from its bulk. Boils, especially if near the auditory passage, require somewhat more than usual attention, as they have sometimes, when protracted in their course, been found to impair the hearing. Cancerous tumours of the auricle, though but seldom met with, may render the amputation of the diseased part necessary, and several cases have been related in which this proceeding was successfully employed. Hypertrophic enlargement of the auricle has also been removed by cutting away the superabundant part. Wounds, if small, heal readily, but if more extensive and irregular, require to be stitched and supported by a proper dressing. The complete loss of the auricle, not a very unfrequent occurrence, will affect the hearing to a greater or less extent, and may be partly remedied by otoplasty, though the experiments made for this purpose have as yet furnished but very imperfect results. (Vide Plastic Operations.)

The external auditory meatus suffers from a number of diseases, requiring the aid of the surgeon. It may be closed, either from congenital imperforation, or in consequence of some inflammatory or ulcerative disease; by foreign bodies introduced into the passage; by a hardened accumulation of the secretion from the mucous lining membrane; or by the growth of polypous or encysted tumours. The membrana tympani is also occasionally found in a morbid condition, seriously impairing the function of the organ, for which relief has been attempted by operation.

Many of these different complaints, to be diagnosticated with certainty, require the exploration of the auditory passage by means of the speculum. This consists of two concave branches, which may be separated by means of a locked handle. That used by Kramer is narrowed near the point; that of Itard is merely conical, shaped like the specula for other portions of the body, but of smaller dimensions. But, inasmuch as the cartilaginous portion of the passage only can be dilated with this instrument, its precise shape is but of minor consequence. The introduction of the speculum may be facilitated by the patient opening his mouth, as the condyle of the lower jaw, when the mouth is closed, presses against the meatus. Care, however, must be observed, to avoid pushing it in too far, as this would cause unnecessary pain; and the branches should be made to press against the upper and lower walls, as these are found the most yielding. If the light falls properly into the ear, after the speculum is applied, we will be able to scan the whole meatus as well as the membrana tympani, which in a healthy state is found glistening at the bottom of the passage.

1. *Foreign bodies in the auditory passage.*—Before any attempts are made to extract foreign substances from the passage, the sur-

geon ought to satisfy himself of their actual presence and their exact situation by examination. This may be best done by pulling the external ear outwards, upwards and backwards, so as to let as much light fall into the meatus as possible; and if the object cannot then be perceived with the eye, a small probe may be cautiously applied to sound the passage. The speculum will but seldom, in such cases, be of any use, and we incur by using it the risk of pushing the foreign substance farther inwards. The instruments for extraction will vary according to the nature of the foreign substance. If it be round and completely fills the passage, a delicate hook, a small curved spatula, or a Daviel's scoop, may be used. If the object be of the nature of a splinter, or a dead insect, it may be extracted with a pair of forceps; but if a living insect has entered, it will be well to drop in a little almond oil, which will either kill it at once or drive it out into view. Hardened cerumen or ear wax will sometimes require to be softened by tepid injections, before it can be removed with a scoop. If the presence of foreign bodies in the ear has already excited considerable inflammation, this has first to be subdued by blood-letting, emollient cataplasms, injections of warm milk, etc., before any attempts can be made at extraction. If any foreign substance has entered into the cavity of the tympanum through an opening in its membrane, the only thing which can be tried is to force it out by a stream of water, injected through the Eustachian tube, a proceeding which Deleau successfully employed in a case where a small pebble had entered the tympanum. After extraction of these foreign substances, the function of hearing is often painfully acute, so that the meatus has to be closed with some wool or lint, until the sensibility of the nerve becomes reduced.

2. *Polypous tumours, encysted tumours, and fungous excrescences in the auditory passage.*—These morbid productions may be developed as a consequence of some constitutional disease, as scrofula or syphilis, or arise from local irritation merely. They spring either from the lining mucous membrane, or the surrounding tissues. The deeper their place of origin, the more difficult will be their removal. Most frequently, however, they are found at the entrance of the meatus, where the structure of the passage is the least firm and resisting. Polypous growths occur here of the same character as in other parts of the body, and are generally covered with a vascular integument, disposed to bleed on the slightest pressure. Those of the vascular kind, by some, are called "sarcomatous polypus," by others, "encysted tumours;" but the soft, smooth, vesiculated tumour, of the nature of mucous polypus, is the kind more frequently met with in the ear. Either may cause deafness, in consequence merely of their obstructing the passage, or by being complicated with some affection of the internal ear; when the latter is the case, though their removal may be effected, it will but little improve the hearing. If the polypus be pedunculated and not seated upon or near the membrana tympani—which, before any operation is undertaken, should be ascertained by the examination of its basis with a probe—it may be pulled out as far as possible with a hook or forceps, and cut off with a pair of scissors or a small probe-pointed bistoury. In many cases it will answer well to twist it off at its root with a small polypus forceps, or, which I prefer, cut it away at once with a small double canula, and a loop of fine silver wire. The removal of these tumours will in common cause but little bleeding;

but if much hemorrhage follow, it is to be arrested by touching the bleeding root with lunar caustic, a measure which has, moreover, the good effect of preventing the re-appearance of the growth. If cauterization should be relied on solely for the destruction of the polypus, which should only be thought of in reference to those of a malignant character and which are but rarely met with, the hot iron is to be employed, though its application is difficult, and attended with danger as regards the neighbouring parts. This danger we may in a degree obviate. The membrana tympani may be protected to a considerable extent by the introduction of a ball of wetted cotton to which a thread is attached, so that it may be pulled out after the application of the cautery. The hot iron should, moreover, be introduced through a tube, so as to be made to act with more precision upon the polypous tumour alone.

The ligature has also been employed for the removal of these tumours from the ear, but its application is found very difficult when the polypus is deep-seated, and is attached by a thick root; cases to which, if it could be successfully applied, the operation seems particularly appropriate. Various complicated instruments have been invented for this purpose, constructed on the plan of Levret's double canula, and the other instruments devised for the ligature of nasal polypi. Sir C Bell recommended in preference to the ligature the pinching of the polypus between the blades of a pair of forceps, which were closed with a screw, and allowed to remain until the tumour dropped off. Krukenberg has succeeded in many instances in destroying tumours of this class by merely pinching them frequently with the common forceps. The application of the liquid caustic by means of a brush, as recommended by Blancard, has been generally disapproved in consequence of the injury inflicted on the surrounding parts. To prevent the reproduction of these tumours after removal, a solution of the acetate of lead was found useful by Kramer, as well as in mere cases of fungous excrescence, where the application of caustics was not thought advisable. Fungous, cancerous, and encephaloid growths sometimes appear in the meatus as the consequence of caries of the bones, or of an affection of the dura mater which has gradually removed the walls of the tympanum. Little can be done in cases of this description—the application of the cautery, the means usually resorted to, having been in most instances found more hurtful than beneficial.

3. *Closure of the auditory passage.*—This occurs sometimes as a congenital defect, and occasionally as the consequence of ulceration. In the former case, the obliteration is usually owing to a membranous septum stretched across the canal anterior to the membrana tympani; in some few instances the septum has been found thick and cartilaginous. When the closure is produced by a membrane only, the passage may be restored. The membrane is to be divided by a crucial incision, the flaps cut off, and the raw edges touched with caustic, so as to prevent their forming a prominent cicatrix. But when the meatus is obstructed by a solid cartilaginous growth, the attempt to open it has been unsuccessful, and the case has been usually found in addition complicated with some malformation of the internal ear.

4. *Catheterism of the Eustachian tube* is found one of the most efficient means of treating cases of deafness that depend either upon an obstruction of this duct, upon an accumulation of mucus

in the cavity of the tympanum, or an impaired condition of its nerves.

Surgical anatomy.—The Eustachian tube forms a passage of communication between the cavity of the tympanum and the throat. Through it the mucous fluid secreted by the tympanic lining membrane is discharged, so as to prevent under ordinary circumstances its accumulation in that cavity. Along it the air likewise passes freely backwards and forwards, so as to preserve that retained in the cavity in a state of equilibrium with the atmosphere, in order to allow the membrana tympani, placed at the bottom of the auditory meatus, and forming the outer wall of the tympanic cavity, properly to vibrate under the impulsion of the surrounding air.

The tube is about an inch and a half in length, and is directed from the cavity of the tympanum obliquely downwards, inwards and forwards, and opens on the *lateral part of the pharynx, a quarter of an inch behind the nostril*, by an oblong, trumpet-mouthed orifice, the posterior lip of which is prominent in the cavity of the pharynx. The greater diameter of this orifice is vertical, and about half an inch long; *its upper and lower angles correspond with the upper and lower boundaries of the inferior meatus of the nose*. The canal leading to the ear starts from the upper angle of this orifice, on a level with the back part of the inferior turbinated bone, and is of a dimension very different from that of the orifice. The lower and inner two-thirds of this tube including the orifice is formed of a membranous cartilage, lined with a mucous membrane continuous with that of the throat, and thickly studded with mucous glands, especially about its open orifice. The upper third is bony; through this part the mucous membrane—converted into a fibro-mucous tissue, so as to serve the part of periosteum—passes up to be continuous with that lining the tympanic cavity. The cartilaginous portion of the tube gradually diminishes in size up to its junction with the osseous, where the diameter is only about the thirtieth part of an inch—so small as barely to admit the passage of a small probe. From this point the calibre again gradually enlarges up to its opening in the tympanum. In the state of rest the parietes of the membranous-cartilaginous portion of the tube lie in contact, the trumpet-shaped orifice alone remaining more or less open, so as to form a sort of long valve patulous at both extremities; this valve, however, is so lightly closed and so elastic as to admit of being readily forced by the breath and the action of the small palatine muscles that surround it, and admits of the passage of air in either direction. The direction of this canal is such as to form with the axis of the inferior meatus of the nose an angle of 135 degrees, which opens obliquely upwards and outwards, and designates the shape of the curve to be given to the instruments intended for introduction. The trumpet-shaped orifice of the tube, as has already been said, is found just behind the inferior turbinated bone; it will also be observed a little to the outer side of the external wall of the nostril of the same side, in consequence of the contraction of the posterior naris, made by the projection inwards of the internal plate of the pterygoid process. The posterior end of the inferior turbinated bone slopes downwards so as to form a cul-de-sac;—was it not for this, a catheter or sound having the proper curve, could be conducted along the inferior edge of the lower turbinated bone, and passed at once without changing its course into the tube. But in attempting the

introduction in this way, we find the point arrested against the cul-de-sac, and it is necessary to lower it so as to pass it over the inner plate of the pterygoid process, and then raise it again to get it into the tube. But if the point of the sound be carried, with the curve vertical, along the floor of the meatus till it is found to glide over the edge of the posterior naris, a rotation of a quarter of a circle, so as to carry the point outwards and upwards, will lodge it in the tube. The distance of the orifice of the tube from the anterior opening of the nostrils varies in different subjects; its medium length is about two inches and a half. Rules have been given in order to ascertain its distance in each case by measurement of the space between the front incisor tooth of the upper jaw—which corresponds with the anterior orifice of the nostril—and the soft palate—which is immediately below the opening of the Eustachian tube.

There are three objects to be effected in the catheterism of the Eustachian tube:—1. The forcing up of air with an appropriate apparatus, for the purpose of aiding in the diagnosis of the diseases which have caused the deafness. 2. The forcing up of atmospheric air, in order to remove obstructions in the tube, or dislodge the mucus that has accumulated in the cavity of the tympanum. 3. The introduction of medicated fluids, whether gaseous or liquid, to remove the morbid condition of the lining membrane of the tympanum, or to stimulate its nerves when they are found obtunded or partially paralyzed, as in cases of atonic deafness.

The introduction of the catheter is to be made through the inferior meatus of the corresponding nostril. But should any irremovable cause of obstruction exist in the nostril of the same side, it is possible also to reach the Eustachian tube through the nostril of the opposite side, by giving a longer curve to the instrument; or even from the mouth, by carrying the catheter upwards behind the soft palate. The last method, however, is abandoned in consequence of the great difficulty attending it.

Ordinary process by the corresponding nostril.—The catheter should be graduated so as to allow the actual distance of the trumpet-shaped orifice to be measured in each case in order to facilitate the re-introduction of the instrument, which is usually many times required. It may be flexible,—made of gum elastic, as the instrument of Deleau, (Pl. LI. fig. 1, 2, B,)—and will then require a stilet; or it may be inflexible,—made of silver or gold. Of the latter, (to which preference is usually given, as they are more readily introduced, though decidedly more liable to irritate the passage,) there are several varieties, the best of which, according to my own experience, are those of Pilcher, (fig. 6,) and Kramer, (fig. 5.) The practitioner who devotes his attention to aural surgery should, however, supply himself with the three instruments above named, as he will occasionally meet with cases in which, either from the small dimension of the nostril, the inclination of the nasal septum to one side, or the great irritability of the passage, one of these instruments, which differ so much in their form, can alone be readily introduced. The peculiarity of that of Kramer, is the shortness of its beak; it can be passed therefore but a small distance into the tube, and allows of the regurgitation of the air and the removal of mucus by its side, so as to prevent any extreme compression of the parts in the tympanic cavity, which is far from being unattended with danger—death

having in one case suddenly followed this operation. For the same reason, the tube of Kramer is liable to displacement, and requires an apparatus to fix it in its position, and may in many cases be advantageously superseded by that of Pilcher, which is moulded to the shape of the parts, so as to sustain itself when once introduced.

The other instruments required will be a frontlet, to which is attached a pair of forceps moving on a ball and socket joint for the purpose of retaining the instrument of Kramer in position; an apparatus for the condensation and transmission of air, and another for the generation of ethereal vapour, which will be found described in the various treatises on the diseases of the ear. Gairal has advised the use of a large gum caoutchouc bottle for air injection merely, the air being forced in by pressure with the hand.

The patient is to be seated on a low chair, with his head thrown a little back and supported against the breast of an assistant. The operator, seated on a higher chair in front and a little to one side, takes in his hand the catheter, well coated with cerate or mucilage, blows through it to see if the passage is per-

fectly free, and passes it, held like a writing pen, rapidly but gently through the inferior meatus;—the point of the instrument gliding over the floor of the meatus, the curve of the beak presenting its convex part upwards, *and turned a little inwards to keep it away from the inner surface of the inferior turbinated bone.* The right hand may be used for either nostril, but if the operator is dexterous in the use of the left, he will find it most convenient to employ that in the operation on the left nostril. If any impediment is encountered in the introduction, not readily removed by a little further inclination of the point outwards, the instrument is to be at once withdrawn and a smaller one substituted. When it has passed to the extent of two or two and a half inches, the point will be felt sliding as it were, or rather about to slide, over the rounded margin of the nostril, and there will be an involuntary effort at deglutition, showing that the instrument has come in contact with the velum palati. The beak of the sound, *without being carried any further backward*, is now to be turned by a quarter rotation between the thumb and fingers, so that the point shall present upwards and outwards in the direction of a line between the

PLATE LI.—OPERATIONS UPON THE CAVITIES OF THE FACE AND THROAT.

(Figs. 1 and 2.) INTERIOR OF THE NASAL FOSSÆ, MOUTH AND PHARYNX.

The head has been sawn through the middle line, so as to take away the septum of the nose with the portion removed.

References common to figs. 1 and 2.

Line of section of the bones.—*a.* Bones of the base of the cranium. *b.* First six cervical vertebræ. *c.* Upper maxillary bone. *e.* The second large molar tooth, which is removed in fig. 2, in order to bring into view the orifice of the duct of Steno. *d.* Inferior maxillary bone. *e.* Os hyoides. *f.* Cartilages of the larynx.

Section of the soft parts.—*g.* The nose. *h.* The upper lip. *i.* Epiglottis. *k.* Lower lip. *l.* Tongue presenting a side view of the genio-hyo-glossus muscles.

Section of the cavities. (*Nasal cavity.*)—*m.* Superior turbinated bone. *n.* Middle turbinated bone. *o.* Inferior turbinated bone. *p.* Cul-de-sac at the top of the naso-pharyngeal cavity. *q.* Inferior orifice of the nasal duct. *r.* Trumpet-shaped orifice of the Eustachian tube.

(*Cavity of the mouth.*)—*s.* Superior dental arch. *t, u.* Half arches of the palate. *u.* Cavity of the pharynx, opening above into the nose and mouth, and continuous below with the œsophagus, *v.*

OPERATIONS.

(A). *Catheterism of the nasal duct with the sound of Laforest.*—In fig 1, the end of the instrument is hidden in the duct by the inferior turbinated bone.

In fig. 2, a portion of the turbinated bone and mucous membrane is removed to show the sound in the whole length of the duct.

(B). *Catheterism of the Eustachian tube with the sound of Deleau.*—In fig. 2, a portion of the body of the sphenoid bone is removed in order to show the continuation of the Eustachian tube toward the cavity of the tympanum, below and in front of the curvature of the carotid artery. An opening is likewise made in the wall of the tube to show the position of the end of the sound.

(C). *Catheter introduced into the antrum maxillare*, shown in fig. 1.

(D). *Probe introduced into the duct of Steno*, seen in fig. 2.

(E). *Sound of Bellocq*, shown in fig. 2, as employed for the purpose of plugging the posterior nares.—The instrument has been introduced through the lower meatus of the nose, and the spring pushed onward so as to bring its probe-point into the cavity of the mouth. A plug of lint is attached to the point by a thread, ready to be drawn back with it and lodged in the posterior opening of the nostril.

(F). *Catheterism of the œsophagus*, (fig. 1,) as employed for the purpose either of dilating a stricture of this passage or removing poisons from the stomach.

Fig 2

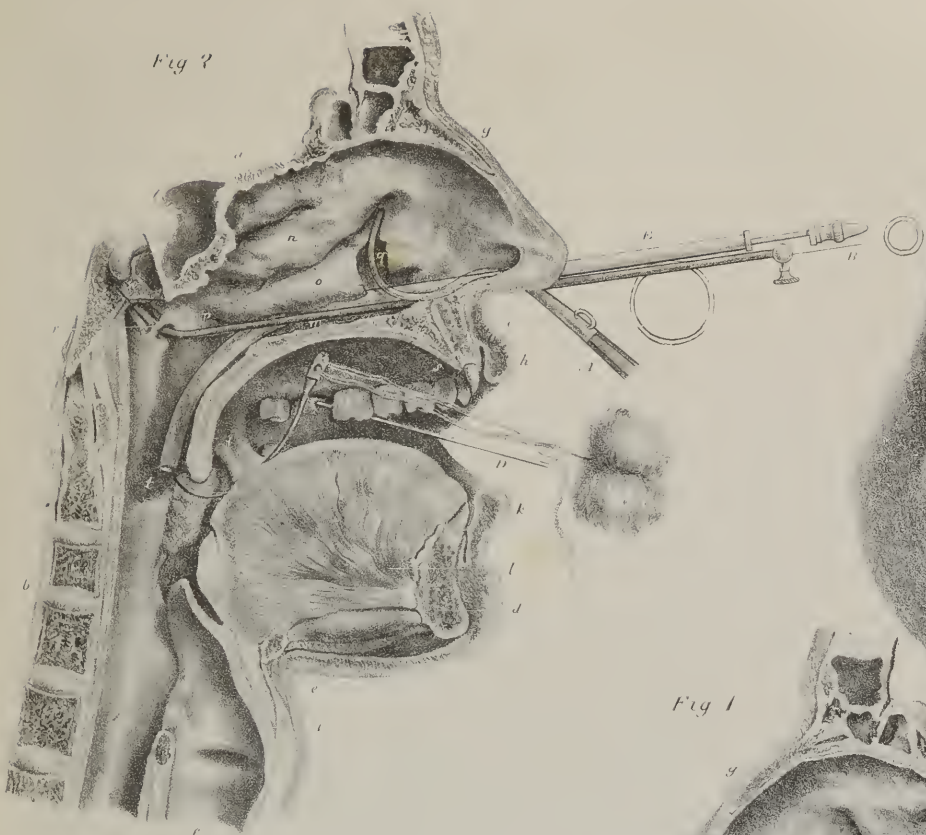


Fig 4

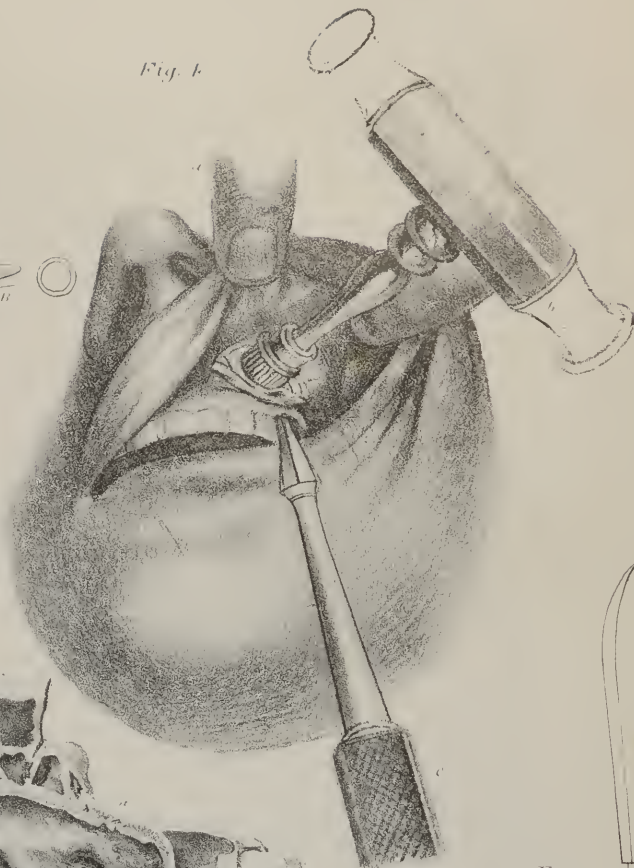


Fig 1

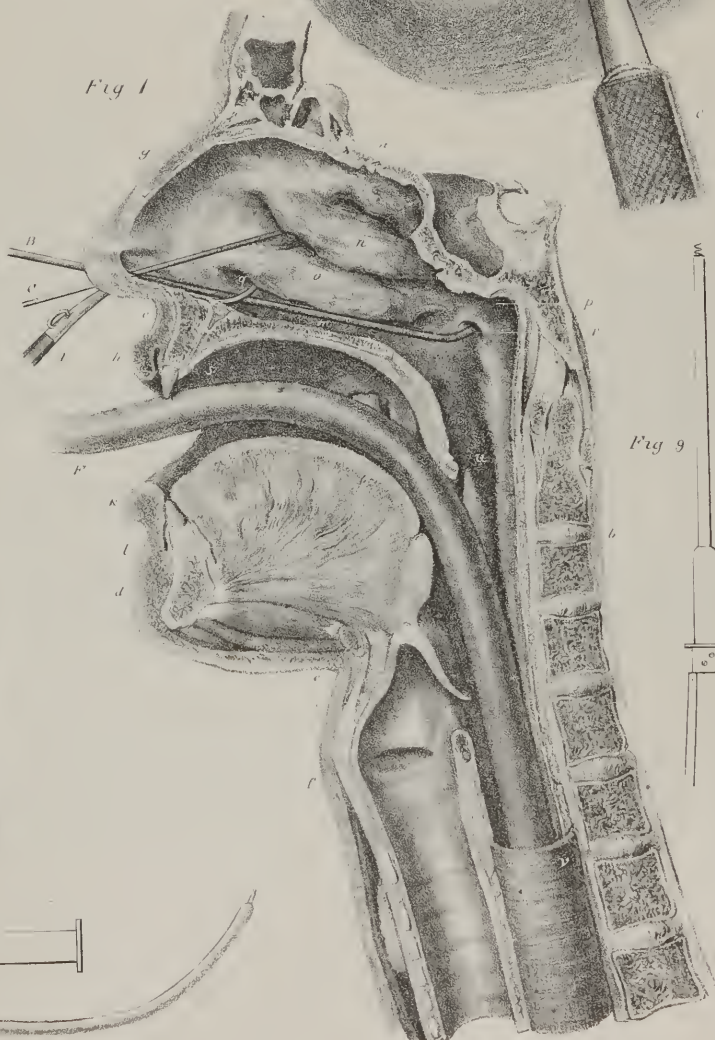


Fig 3

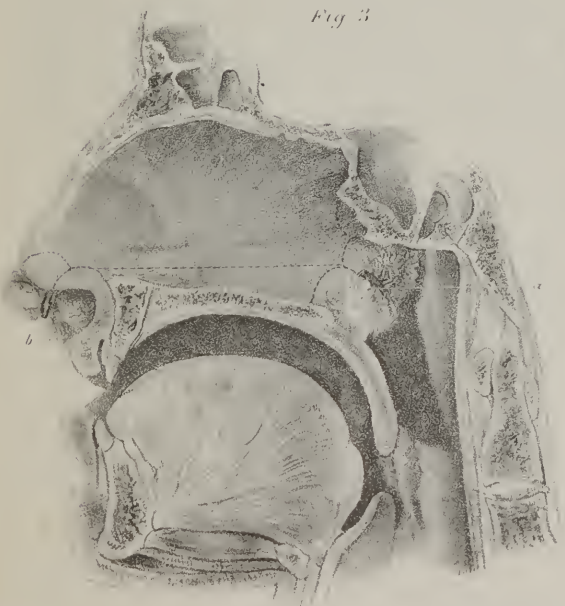


Fig 7



Fig 9



Fig 5



Fig 8

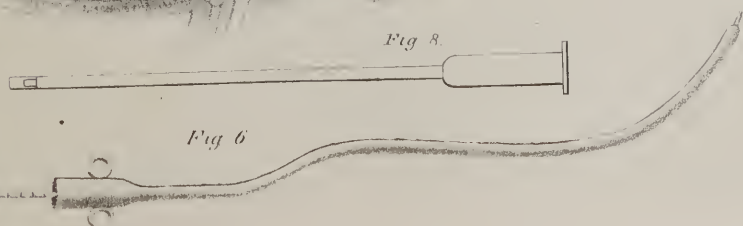


Fig 6

auditory meatus and the first incisor tooth of the other side, with which direction should correspond the ring on the outer end of the catheter. The surgeon then, pushing the instrument gently on, first feels it jut against the posterior lip of the orifice and then slide into the cavity of the tube. To the practised hand its position here is at once made manifest by the absence of uneasiness to the patient, by the instrument becoming gradually more fixed as it glides in, and by a sort of elastic resistance given by the walls of the orifice in attempting to rotate the instrument. The forceps of the frontlet are now to be fastened upon the catheter, which, by this means, is now so securely held that the patient cannot by talking or even swallowing dislodge it. This manipulation, however, should be so delicately done, and with such close attention to the sensation communicated to the fingers, as to avoid even the slightest laceration of the lining membrane, else, when the condensed air is allowed to pass up the catheter, it might get through the place of rupture into the submucous cellular tissue, so as to produce an emphysematous swelling of the palate, the uvula, or of the side of the neck as far down even as the angle of the jaw. If, in introducing the instrument, we attempt to make the turn before it has arrived at the posterior border of the nostril, the point will be brought up against the back end of the inferior turbinated bone, so as to occasion pain, and, in case any violence should be used, even fracture of the part. If, again, after making the rotation, the point instead of entering the cavity slip over the posterior margin of the orifice of the tube, a sensation of elastic yielding in the part makes the circumstance known to the surgeon. The instrument, if then carried back, comes in contact with the walls of the pharynx, and produces a convulsive contraction of the muscles of deglutition. If it be rotated in this position, it either swings round clear in the cavity or becomes hooked in one of the angular depressions of the pharynx—a state of things which the young operator should early learn to detect. When hooked in this way, he will discover his error by noticing that the direction of the ring on the outer end is too vertical; that the instrument,

as shown by the graduated scale, has entered too far, and by observing on attempting to rotate the instrument, that it does not meet with the peculiar elastic membrane of the cartilaginous orifice while it increases the spasmodic action of the muscles of deglutition. He is then to retract the catheter. If he discover the error the moment it slides over the posterior lip, a slight backward motion is all that is required, and the instrument, if again pressed forwards with the handle a little more inclined to the other nostril, slips into the proper position. If he do not find his mistake till the point has touched the back wall of the pharynx, he is to turn the handle till the ring comes into its proper direction, and then withdraw the instrument for half an inch, which brings the point nearly opposite the tube, when a second effort to pass it may be made. If not successful now, the instrument must be brought backwards with the point in the position at which the turn was made in the first instance, and the manœuvre repeated anew.

When the nostril is of good size, I often find it more easy for the patient—in introducing the catheter of Pileher—to carry it with the convex part of the curve downwards on the inner and lower angle of the meatus, the point directed upwards under the inferior edge of the lower turbinated bone, so as to correspond with the direction of the Eustachian tube. If there is no resistance at the posterior end of the turbinated bone, no turning of the instrument is required; the point will be found sliding over the rounded edge of the internal pterygoid process, and dropping at once into the proper opening. If there be resistance, the point must be turned a little downwards till it passes, and then raised again to the proper direction.

If the elastic catheter of Deleau is employed, it is to be carried on the stilet in the manner above directed into the orifice of the tube. (Pl. LI. figs. 1, 2.) The stilet which projects a little beyond the catheter, is then to be carried alone along the tube, and the catheter afterwards advanced upon it. The stilet is then wholly withdrawn, leaving the catheter in place, to the end of which a

(Fig. 3.) TAMPONING THE NASAL FOSSÆ.

In the section of the head shown here, the septum narium has been left. The operation—the first step of which is seen at E, fig. 2—is here represented completed. The horizontal dotted line represents the track of the thread; the curved ones at the two extremities of the nostrils show the depth to which the plugs (*l, m*) are lodged in the passage.

(Fig. 4.) PERFORATION OF THE ANTRUM MAXILLARE.

(A). *Through the external wall.*—The corner of the mouth is carried outwards and the upper lip raised by the two hands of an assistant, (*o, p.*) The mucous membrane has been divided at its place of reflection from the gum, and the soft parts separated upwards from the bone so as to give room for the application of the small crown of a trephine.

By the sockets of one of the molar teeth.—The first small molar tooth having been lost, the point of a perforator is applied in this case to drill a passage into the antrum.

Fig. 5.—Kramer's catheter for injection into the Eustachian tube,—this instrument is made of various sizes.

Fig. 6.—Mr. Pilcher's catheter for the same object, reduced one-third in size.

Fig. 7.—Shaft of Fabrizi's instrument. A spiral screw at the end. A coiled wire spring near the handle.

Fig. 8.—Canula of the same, made of silver, with a circular steel point which is sharp and cutting.

Fig. 9.—Shaft placed in the canula, the spiral point projecting two turns beyond the canula.

mouth-piece of silver is to be fixed, and subsequently fastened to the alæ of the nose by a metallic thread bent so as to act as a pair of forceps.

Introduction of the catheter by the opposite nostril. (*Process of Deleau.*)—The catheter employed in this process must have a longer curve than the one ordinarily used, and is more convenient if made of gum elastic. It should also in addition be slightly curved on the side of its convexity. It is to be passed, held as a writing pen, through the nostril of the other side, with the concavity of its beak looking downwards and inwards. As soon as the point has passed the boundary of the posterior naris, it is to be rotated inwards so as to pass behind the vomer. In this direction it is to be continued on till it enters the orifice of the tube of the opposite side.

Perforation of the membrana tympani.

This operation was introduced by Sir A. Cooper, and it is said successfully employed by him in 1800. The perforation is made either by puncture or excision. The only indications commonly believed to justify this operation, are permanent and irremediable closure of the Eustachian tube, extravasated blood in the cavity of the tympanum, and, according to Kramer, a thickened and unyielding state of this membrane. The success of the operation, which has been very frequently practised, has not however been such as to realize the expectation once formed from it. "Nothing is more rare," says Itard, "than the cure of deafness by perforation of the membrana tympani."* I have several times in years past, performed the operation, but have seldom found it attended with much lasting benefit.

Puncture.—Cooper and Buchanan, after inclining the head of the patient in a good light and straightening the meatus in order to render the membrane visible, punctured the membrane with a small trocar at its anterior and inferior portion, so as to avoid the manubrium of the malleus—care being taken that the point of the instrument should not come in contact with the opposite wall of the tympanum. The puncture, however, even when first attended with benefit, was found soon to close up as in ordinary wounds of the part, by adhesive inflammation. Hence the introduction of the following process for the removal of a piece.

Excision.—This process was first devised by Himly, and executed with a simple circular punch of small size, cutting out like that of the shoemaker, a circular piece. With this instrument the delicate membrane is more apt to break away than be clearly cut, the broken portions subsequently rising up when inflamed, so as to diminish or obliterate the orifice. For these reasons the punch of Himly has been modified by Deleau, for the purpose of bringing away the piece, and further improved by Fabrizi, of Modena. By the instrument, as modified by the latter surgeon, the removal of the piece is readily accomplished.

Process of M. Fabrizi. (Pl. LI. figs. 7, 8, 9.)—The structure and mechanism of this ingenious auricular *trephine* of M. Fabrizi, will be understood by reference to the plate. It is used in the following manner:—Holding the instrument in the right hand as a writing pen, with the point of the spiral directed upwards, it is to be passed along the inferior wall of the meatus, and brought in contact with the anterior and inferior part of the membrana tym-

pani at a point about half a line from its circumference. Pressure is then to be made on the instrument till the point of the spiral traverses the membrane. The whole instrument is then to be rotated on itself for a turn and a half. The handle, to which the shaft with the cork-screw termination is attached, is then to be secured with the fingers of the left hand, while with those of the other hand the canula is rotated a turn and a half in a direction opposite to that which had previously been made. The screw fixes the membrane so as to give the requisite point of support, and the sharpened edge of the steel canula cuts out a round piece about a line in diameter, which is left attached to the screw, and is withdrawn with the instrument. This mode of excising a portion of the membrane is incontestably superior to any which has yet been devised.

Perforation of the mastoid cells.

This operation was proposed by Itard, and has been many times practised for abscess of the tympanic cavity with supposed effusion of pus in the mastoid cells, and for the purpose of throwing injections into the tympanum in cases of obstruction of the Eustachian tube. But the method has never met with much favour, and though a plea has recently been started in favour of its resumption,* it may be considered as completely laid aside in reference to the above indications. For if, under such circumstances, the purulent fluid cannot be evacuated by injections through the Eustachian tube, it is generally conceded that it is better to make an opening through the membrane of the tympanum. The only cases in which the perforation of the cells would be admissible, are those in which the abscess within is complicated with caries or necrosis of the outer wall of these cells. The point on the surface which corresponds to the position of the larger of these cells is a little in front of the mastoid process, and in the adult a little more than half an inch from its apex. The operation would consist in laying the bone at this point bare, by a crucial or T incision, and employing a small trephine to open into the cells. Through the opening the pus is to be discharged, and injections cautiously thrown in from day to day, till a cure is effected.

III. OPERATIONS UPON THE NOSE AND NASAL CAVITIES.

Surgical anatomy.—The bony structure of the root of the nose is formed by the two nasal bones, which are attached upon each side to the nasal process of the upper maxillary, and by their posterior face to the perpendicular lamella of the ethmoid bone. From this junction of parts, it follows that in fracture or depression of the nasal bones the shock may be transmitted to the cribriform plate of the ethmoid, so as to break it and cause injury to the brain and olfactory nerves which are lodged above it. If the fracture involve the nasal processes of the maxillary bone, the nasal duct for the discharge of the tears is liable to injury, and

* Mémoires de l'Académie Royale de Médecine, tom. V. Paris, 1836.

* M. Deseimeris.—De la Perforation de Apophyse Mastoid, etc. etc. L'Expérience, 10ème Avril, 1833, No. 32.

epiphora or even fistula lachrymalis may follow. The inferior half or expanded portion of the nose, called the *alæ*, is composed mainly of two lateral cartilages, separated by a *hird* which completes the nasal septum. The skin of the nose is thick and movable over the bones; but thin and closely adherent over the lower cartilaginous portion. The subcutaneous cellular tissue contains no fat, but is richly supplied, especially at its inferior part, with sebaceous follicles, the orifices of which are so numerous as when enlarged to give the skin a cribriform appearance. The integuments of the nose are so very vascular as to render easy the cicatrization of wounds of the part, and make it the frequent seat of erectile tumours. A case is reported by Garengeot, in which the re-application of the extremity of the nose, after it had been completely separated, was followed by solid union.

Nasal cavities.—Each of these cavities is included within the bony and cartilaginous walls of the nose just described, and the upper surfaces of the horizontal processes of the maxillary and palate bones which form the roof of the mouth, and are separated from each other by a partition partly bony and partly cartilaginous—consisting of the *vomer*, the perpendicular plate of the ethmoid bone, and the triangular cartilage which is lodged in front of the bony portion. Each of the nasal cavities or nostrils thus formed with resisting walls, presents an opening in front called the anterior naris, and one behind leading into the pharynx and closed at times by the *velum palati*, named the posterior naris.

Anterior nares.—Each of these openings is about three-quarters of an inch long and a quarter broad. Their walls, which are cartilaginous and extensible, may be further enlarged by a section of the *ala* with the knife, so as to be equal to that of the bony orifice of the nostril which it masks, and which is about half an inch in its transverse diameter. Each of the anterior openings is circumscribed—on its outer side by the *ala*, on its inner by the nasal column, on its lower or posterior by the origin of the lower lip, and on its upper or front by the nasal lobe or point. It is well to observe, in reference to the introduction of instruments through this opening, that the point of the nose descends much lower than the origin of the upper lip, so that instruments in entering should be first directed upwards, and then brought to the horizontal position.

The *posterior nares*, or *openings of the nostrils*, are of a regular oval shape, each fully three-quarters of an inch in its vertical diameter, and half an inch in its transverse, opening obliquely backwards and downwards into the pharynx. The walls of these orifices are bony and unyielding. The size and shape of the orifices should be well noted by the student in reference to plugging them in case of epistaxis, or the passage of instruments for the removal of polypous tumours. In looking in a section of the head from behind forwards through the posterior opening of the nostrils, we find these cavities formed of four walls—the external, which is irregular in consequence of the presence of the turbinated bones on that side, the two lower of which may be seen from the posterior orifice; the superior, or the roof; the internal, or the septum; and the inferior, or the floor.

The *inferior* is about two inches long, formed into a sort of gutter on its upper face, which, when the head is placed horizontal, is found inclined backwards and slightly downwards. By its

posterior part it supports the *velum palati*, a sort of movable valve, which, when elevated, obstructs the posterior orifice, and forms one of the difficulties in the introduction of instruments from the mouth into the nose. The mucous membrane lining this inferior wall is fibrous, little sensitive or vascular, and is but seldom the place of origin for polypous tumours.

The *internal wall or septum* is lined by a very dense, vascular, and sensitive mucous membrane, which favours the development of syphilitic or scrofulous ulceration, and is not unfrequently the seat of fibrous polypi. The septum is, in a large proportion of cases, found bulged more or less to one side, so as to render one nostril smaller than the other. When this takes place to a great degree, the front end of the triangular cartilage of the septum will form a red and rounded tumour, interfering with the passage of air. I have frequently been consulted in regard to this displacement of the cartilage, the patient believing it to be a polypous formation; but if a bent probe be passed in these cases into the other nostril, it falls into a corresponding concavity, and reveals at once the nature of the affection.

The *superior wall or roof* of the bony portion is very narrow—little more than a sixth of an inch broad. It is formed in front by the nasal bones and the septum. In its middle part it is horizontal, and is formed by the grooves of the ethmoid and the cribriform plate of that bone, the fragility of which is so great that an instrument improperly directed, especially in the softened state in which the bone is found in disease, might readily penetrate into the brain. This horizontal portion is lined by a delicate mucous membrane, and is the common seat of vesicular or mucous polypi. At its back part the wall inclines downwards, and terminates directly at the orifice of the sphenoidal cell.

The *external wall* is irregular in structure, and is formed chiefly by the three turbinated bones and the three meatuses which they cover. The inferior turbinated bone begins from the very margin of the nasal process of the maxillary, nearly on a line with the bulging part of the *alæ*, and runs back, a little arched in its middle, to the front part of the inner plate of the pterygoid process. Its upper margin, by which it is attached to the nostril, is nearly on a line with the front margin of the orbit, and about five-eighths of an inch above the floor of the nostril. This bone is curved inwards and downwards, so that its inferior edge comes usually within a quarter of an inch of the floor, and sometimes is provided with a fold of mucous membrane so pendulous as to reach, especially at its back part, nearly down upon the floor. In the inferior meatus, which is found below it, opens the nasal duct, the anatomy of which has already been described. The middle turbinated bone begins about half an inch further back, and nearly an inch higher, being nearly on a line with the internal canthus of the eye. The space between the lower margin of this bone, and the upper margin of the inferior, which forms the middle meatus, is only about three-sixteenths of an inch broad. In the front part of this space, and under the inferior turbinated bone, open the anterior ethmoidal cells and the frontal sinus—and at a point a little farther back, at the distance of about an inch and a half from the anterior nares, is the orifice of the antrum highmorianum. Professor Warren* has observed, that an unusually large turbinated bone is liable to be mistaken for a polypous growth.

* Surgical Observations on Tumours, p. 470.

The middle turbinated bone is convex and curved inwards like the lower, but does not come so far forwards. Its convex surface is, however, nearer to the septum—often so near, when the septum is curved a little in that direction, as not to leave more than the eighth of an inch between them, and present an obstacle to the introduction of instruments through the nose. The back part of this middle turbinated bone is curved a little downwards. The upper or small turbinated bone is directed a little upwards, and seems like a detachment from this, starting on a level with the internal canthus of the eye. The space thus left between them forms what is called the superior meatus, and is consequently found only in the posterior half of the nose, and is about three-quarters of an inch long. In it is the opening of the posterior ethmoid cells. In the skeleton it presents also the orifice called the sphenopalatine foramen, through which, by constant pressure and dilatation, large polypi occasionally insinuate themselves, so as to project in the pterygo-maxillary fossa below the masseter. All these parts are covered by a red, soft, mucous membrane, very vascular, especially at its upper part, where it becomes, in consequence of its high organization, the seat of coryza, hemorrhages, and bleeding polypi. In the extraction of nasal polypi, it is necessary to be familiar with the structure of this external wall of the nose, though when the tumours are large it will be found more or less distorted by their pressure. They rarely arise from the inferior turbinated bone, but when they do, they may readily be removed by a pair of forceps either straight or slightly curved. The most common seat of such as spring from the outer wall, is the middle turbinated bone, though they are not unfrequently found attached to the upper bone. The instrument for the removal of these by grasping their root must necessarily be curved, and carried up nearly on a level with the lower side of the nasal bones. "Whoever looks," says a most judicious writer,* "at the position of these bones, even in the dead skull, and the relations of a polypus, must at once be convinced that its eradication by any plan whatever is rather to be desired than promised, and the rapid reappearance of polypi, after the nostril has been conjectured to be cleared, is easily to be explained by an excrescence expanding from a spot where it had been confined by the portion removed. The destruction of bone, and dreadful spreading of the disease, may also be readily understood. It sometimes destroys the nasal bones, forming an external tumour, enters into the antra, and swells the face laterally as well as in front, penetrates into the frontal and sphenoidal cells, swelling the forehead, and pressing on the brain protrudes the eyes and pushes forward the conjunctiva, descends into the pharynx, encroaches on the palate, and perhaps carries the velum forwards almost to the front teeth."

TUMOURS OF THE NOSE.

These may consist of a mere enlargement of the sebaceous follicles, or of a growth of erectile tissue, or they may be of the nature of lupus or cancer. The processes for their removal will not in common differ from that required when the same affections are found in other parts of the body, with the exception that it

will be necessary to avoid cutting into the nasal cavity, for fear of leaving a fistulous opening or a deforming cicatrix. But in cases of malignant disease, as when a wart over the ala has unequivocally become cancerous, the extension of the disease inwards renders it often necessary to remove by an elliptical incision a portion of the entire wall, the orifice of which, if small, should be closed at once with the hare-lip suture; or if large, by the immediate transplantation of a flap from the cheek, forehead, or arm. If a tumour, malignant or otherwise, grow from the middle column of the nose, separating the two oval cartilages, it may be removed by the following process, so as to leave very little deformity.

Process of Rigal.—This consists in circumscribing the tumour of the column by two lateral incisions united in front, and divergent backward in the form of the letter Λ reversed. The branches are next to be united by a transverse incision nearly on a level with the lip. The integuments are then to be dissected off from the place of these incisions, and the two oval cartilages separated so as to expose the septum within and allow the diseased mass to be enucleated from between them.

Lipomatous tumours of the nose.—The skin and subcutaneous cellular tissue covering this organ, as well as the numerous sebaceous follicles they contain, sometimes become so thickened and irregularly expanded, as to form a mass of insensible lobulated tumours, pendent from the part, though attached by broad bases. The cellular tissue below is loaded with serum so as to augment the size of these swellings, the growth of which, if not removed by operation, goes on increasing without definite limits, producing great deformity and inconvenience, hanging down so as to obstruct the orifices of the nose and mouth; and in two instances have been known to descend as low as the chin and chest.* They are mostly of a reddish or violet hue from the accumulation of blood in the veins, though the arteries of the part are but little enlarged. The masses are separated by fissures, in which the sebaceous secretion lodges and becomes rancid and offensive. The affection is not malignant, and the cartilaginous basis of the nose being usually uninvolved, the growths may be readily removed from it by operation.

Process of Mr. Liston.—"An incision should be made through the diseased integument and cellular tissues in the mesial line, upon the cartilages of the apex and columna—not, however, so as to injure them. An assistant places his fore finger in one nostril, and the surgeon, seizing the mass either in his fingers or with a small vulsellum, (toothed forceps,) proceeds to dissect it off with a scalpel. The incisions must be carried close to the cartilages of the ala until the one side is cleared—the edge of the opening being well observed, and not encroached upon. The assistant will give warning if the knife at any stage of the proceeding, approaches his finger. The surface is trimmed a little, if occasion requires, with a pair of thin, slightly curved, or knife-edged scissors. A similar proceeding is observed on the opposite side so as to make the part as symmetrical as possible. A few vessels bleed, but the flow is easily restrained during the dissection by placing the small spring forceps (Græfe's) upon their mouths, or compressing them with the point of the finger. Ligatures are afterwards applied if they still persist in bleeding. Should

* Principles of Surgery, Vol. II, p. 227. By John Burns, M. D., F. R. S. London, 1838.

* Vidal, Traité de pathologie externe, Vol. IV.

the ligatures not hold, the cut ends of the vessels not being readily drawn out from the condensed tissue, a fine cambric needle may be passed across the bleeding point, and a ligature tied under it, the ends of both the needle and the thread being afterwards cut off. Any troublesome general oozing may be stopped by plugging the anterior nares, applying a compress of lint outside, and retaining it by a double-headed roller. Difficulty and pain, however, are experienced in removing this dressing, and it is much better, if possible, to apply frequently and assiduously for a few hours, pledgets of lint moistened with cold water; and after coloured discharge has ceased, to substitute the tepid dressing, and thus encourage suppuration. The exposed surface in this situation soon becomes clean, and presents small, pointed, and florid granulations; after a time the zinc or other lotions, well diluted, are employed with advantage. Cicatrization very soon takes place, and the surface at first glazed and discoloured, soon assumes a perfectly natural appearance.”*

Occlusion or narrowing of the anterior nares.—Diseases susceptible of altering the form of the nose may obliterate or contract the nostrils, so as to interfere with the function of respiration. As in the occlusion of the other natural passages, this is to be treated by the common processes of dilatation, incision or excision, which, to be effectual, have frequently to be employed in combination.

In cases of simple narrowing, make with the bistoury many small radiated incisions at the margin of the nostril. If the closure be complete, run the bistoury in the place of the former opening so as to form a longitudinal fissure, and if the structure be unyielding and resistant, excise the margins so as to leave an oval opening. The new orifice is to be kept open till the raw edges are completely cicatrized, by a roll of charpie, a canula, or a stick of lead formed into a flattened ring.

NASAL CAVITIES.

The affections which require operation in the cavities of the nose, consist chiefly in the lodgment of foreign bodies—epistaxis and polypous tumours.

Extraction of foreign bodies.—Foreign bodies, such as peas, beans, small stones, sticks, &c., are mostly introduced accidentally or in childish sport, through the anterior nares, and become after a short time firmly fixed, either by their own enlargement from the imbibition of the moisture of the part, or from the tumefaction of the surrounding membrane, which keeps them as it were enclosed. Many instances are narrated of foreign substances which have been developed in the passages, and become the source of great irritation. Wepper has seen a nasal calculus, for which a tooth, the only one that remained in the mouth, projected so high as to form by its root the nucleus of the concretion. Kern speaks of having seen a nasal calculus the size of a nut, and Græfe has met with two—one in a gouty subject, and another which was developed round a cherry stone; and a concretion formed in a manner somewhat analogous is noticed in the recent lectures of Sir B. Brodie. Leeches may escape up the nostril, so as to produce excessive hemorrhage; but they seldom require the introduction of instruments for their removal, as they are readily killed by the snuffing up, or the injection of salt and water.

Simple measures will usually suffice for the removal of these substances. A pair of ear, or small nose forceps, with the blades carried up vertically on each side of the substance to be removed, the scoop end of a director, or a blunt hook made by bending the end of a probe, will usually answer. If living insects occupy the cavity, injections of olive oil, by closing their spiracula, will usually dislodge or destroy them.

Plugging or tamponing the nostrils in nasal hemorrhage.

“Plugging the nostrils,” says Professor Ferguson, “for epistaxis, is often a more troublesome process than might be imagined; but if the student practice this a little on the dead body, or have an accurate knowledge of the direction of their passage, or do not employ instruments too complicated, he will, I believe, find but little difficulty in accomplishing his object. The vessels from which the hemorrhage proceeds are usually high up, and consist of capillary branches from the lateral nasal artery, the trunk of which enters at the sphenopalatine foramen. The trunk near its place of entry may be nearly reached by a flattened probe slightly bent outward at the end, and carried for two inches and a half from the root of the septum, obliquely upward and backward, and close to the side of the septum. But it cannot here be effectually compressed without using such force as might endanger the structure of the delicate bones at this part; and it is best, therefore, so far as local means are concerned, to trust to such measures as will produce a coagulation of blood in the passage—for, from the description of the structure which has already been given, and the site of the hemorrhage, it will be seen that even when the nose is apparently fully stopped, it is not by direct compression on the bleeding surface, which cannot be made to act so high that the bleeding is arrested, but by the indirect compression resulting from the coagulation of the blood in the passages.”

When the therapeutic measures usually directed for the purpose of overcoming the determination of the blood in cases of sanguine congestion, fail of their object; or when, in cases of bleeding arising from local causes, as the removal of polypi or traumatic injuries, the ordinary topical remedies, such as the snuffing or injection of cold water or astringent or acidulated solutions through the nostrils—or the insufflation through a quill of powdered gum Arabic, alum, gall-nuts, catechu or charcoal, which coagulate the blood and produce with it an adhesive mass that acts as a plug upon the bleeding surface of the mucous membrane—are all found ineffectual, as they are apt to be when they produce violent sneezing, it becomes necessary to plug the nasal fossa. The most simple method of effecting this object is to wind a piece of lint, of the length of the inferior meatus, and well wetted in a solution of alum, round a probe, so as to form a bulk sufficient to fill this cavity, into which it is to be introduced and allowed to remain for two or three days. It is not, however, uniformly successful, as we cannot close thoroughly by this means the posterior orifice, which it has been shown, is larger than the anterior. This process is, moreover, even when successful in arresting the discharge, liable to be followed by troublesome irritation of the mucous membrane.

Common process.—The method altogether the most efficacious, prompt and least irritating for arresting the flow, consists in the

* Practical Surgery, edited by Dr. Norris, p. 285.

plugging of the two orifices merely. This may readily be effected in the following manner with the catheter of Bellocq. (Pl. LI. fig. 2.) This instrument consists of a silver tube of the size and curve of a female catheter, open at the ends, through which a watch spring passes, and furnished at the entering extremity with a smooth rounded button, provided with an eye for the purpose of carrying a thread. Through the eye is passed a small but strong waxed thread, the lower end secured with a knot, so as to prevent its escape and form a loop. The instrument is introduced through the bleeding nostril with the button drawn up. When the end with the curve downward has reached behind the palate, the spring is pushed onward so as to make the button turn round the velum and present itself to view in the cavity of the mouth. The loop of thread is now to be quickly drawn out between the lips, but without detaching its connection with the button, and to its end is affixed a pledget of lint, or a small piece of sponge, of a size sufficient to close the posterior naris, and without being so large when applied as to interfere with respiration by the mouth; to this plug a single thread should have been previously attached for the purpose of being left hanging from the mouth to aid in its subsequent extraction. The spring is now to be drawn forwards, so as to bring the button again to the mouth of the catheter. The instrument is then extracted, drawing with it the plug to the posterior naris, the plug being aided by the end of the finger in its passage round the velum. The thread is next to be detached from the button, and drawn with a little force, so as to lodge the plug securely in the posterior opening; the two ends are then to be separated in front, and knotted over another pledget introduced between them into the anterior orifice. The two orifices are now completely closed, and no more blood can flow than is sufficient to fill the nostril, when it must coagulate and make compression against the bleeding surface. The thread hanging by the mouth is to be drawn out loosely at one of the corners and attached by a strip of adhesive plaster to the cheek. When the plugs have remained a sufficient time, the anterior is removed by cutting the knot, and the posterior dislodged by a probe carried through the nostril and is drawn out through the mouth with the string left for that purpose. The usual direction in regard to the use of Bellocq's instrument is not to thread the button till after it is projected into the mouth, when it is to be seized and drawn forwards for the purpose. This plan, however, renders the operation more protracted, and more distressing to the patient, in consequence of the pressure which is necessarily made on the irritable velum. The proceeding above recommended I have found decidedly more advantageous in practice.

The instrument of Bellocq is not, however, always at hand, nor is it absolutely necessary in plugging the nostrils. A piece of bent wire, a long probe, a strip of whalebone—bent by heating one surface over a candle, a curved bougie or catheter, may be made to carry a thread into the throat, when it can be seized through the mouth with a blunt hook or a pair of instruments.

Process of the Author.—I have very often employed the following simple process, which is easy of execution, attended with as little inconvenience to the patient as any other, and requires no instrument that is not wanted for other purposes, and which may be carried in the pocket case. Pass the ordinary catheter for the injection of the Eustachian tube through the nostril, and

let the curved end project downwards into the pharynx. Through the cavity of this introduce a piece of catgut, the end of which is to be seized below the velum and drawn out through the mouth with a pair of forceps. The tube is then to be withdrawn from the nose, leaving the other end of the catgut projecting from the nasal orifice, and the loop lying loosely round the palate. The extremity projecting from the mouth is to be doubled down, and to this the two ends of the double thread which have been tied upon the pledget are to be firmly attached. The catgut is then to be withdrawn through the nostril so as to bring out these ends; the pledget being carried up, and the operation completed as in the process with the instrument of Bellocq. The loop of catgut does not produce the same irritation in the fauces as the spring stilet of the latter instrument, which is too sharp and cutting on the edge.

To avoid altogether the inconvenience of passing instruments by the mouth, M. Martin St. Ange has devised the following ingenious and complicated apparatus. "It consists of a straight canula, four inches in length, widened into the form of a cone at the extremity which is not engaged in the nose, and terminating at the other by a small perforated nipple. The widened extremity has two rings like a catheter, and a small cock at the distance of five lines. Beyond this a slide plays, which may be tightened at pleasure by a screw. For the extent of an inch from the outer extremity, circular grooves are made, and a small bladder, formed of the cæcum of a sheep, is fixed on the grooved extremity by a firm ligature. To be still more sure that the bladder may not be thrown off from the tube, it is connected by a thread with one of the rings of the handle. The bladder, being softened and folded round the tube, is introduced towards the pharynx, and filled with air or water by injection, which is retained by turning the cock. Slight traction is then employed to draw the small bag closely against the posterior aperture of the nares. A piece of linen is placed in the orifice of the nares, on which the screw is to be advanced, and the instrument fixed by its pressure. The whole apparatus can be withdrawn at will by opening the cock, when the bladder, more or less empty, brings forward the clots contained in the nose."*

POLYPOUS TUMOURS.

These are growths varying in structure and consistency, but mostly pear-shaped and attached by a stem; frequently developed in the cavity of the nostrils, and found occasionally in all the other passages which open on the surface and are lined by a soft membrane. Their causes and pathology are but imperfectly known. Those of the nose are divided into two classes—the *soft* and the *hard*. The former are yielding in their structure, mould themselves to the shape of the nostrils, and if they attain to a size too great to be accommodated in the region in which they grow, advance so as to appear or even project at the anterior or posterior nares, without producing in common any *very great* deformity of the nose. The soft includes several varieties:—1. The *mucous* or *vesicular*, consisting of an elongated sac, which is hygrometrical, and filled with a mucous fluid; the sac becoming more distended and prominent during damp weather. This va-

* Epistaxis, by T. S. Wells, *Cyclop. Pract. Surg. and Journ. des Connaissances Médicales*, tom. ii. 1834—5.

riety has its origin, according to Deschamps the younger, in the submucous cellular tissue, either directly as a consequence of a relaxation of the folds of the mucous membrane, or from a preternatural growth of the cellular tissue which pushes the membrane before it. This is probably the true explanation. Garengot, Heister and Nessi* supposed them to depend upon the development of the muciparous follicles; which, upon their orifice becoming obliterated, enlarge from a collection of fluid, and become pendulous so as to form a tumour. 2. The *lardaceous*, which resembles the former, except that its interior is divided into cells and filled with a concrete, friable, albuminous, fluid. Both these varieties have an oyster-like appearance, and are pale or straw-coloured; they commonly grow, as before observed, from the roof and upper part of the external wall. 3. *Fungous* or *bleeding* polypus, usually distinguished as *malignant*. Tumours of this description have a red or livid colour, and are spongy in their structure. They are very liable to bleed when irritated, and often give rise to spontaneous hemorrhage. They occupy the whole thickness of the lining membrane, and sometimes invade the bone. When removed they are exceedingly prone to sprout anew, and have a strong tendency to cancerous degeneration. 4. *Granular*. These are not usually of large size, consist of a collection of grayish or rose-coloured granules, and resemble closely the syphilitic vegetations which grow from the mucous surfaces of the genital organs, to the nature of which they are sometimes allied. Occasionally they are developed in young persons of a scrofulous habit, in whom, even after their most cautious removal by instrumental means, or by the use of ointments, as recommended by Sir B. Brodie, they are liable to be followed by ozæna. The first two varieties of this class fortunately form the greater portion of the polypous tumours met with in practice.

The *second class* or the *hard* consists also of several varieties—the *fibrous*, the *sarcomatous*, and the *cartilaginous* or *osseous*.

The *fibrous* polypi are pediculated, grow from the fibrous tissue of the part, are smooth on the surface, of a grayish-white colour, and covered with delicate arteries and veins which spring from larger trunks that enter through the root. They are commonly attached by a broader base than the soft polypi, and may grow from any portion of the fibrous covering of the walls of the nostrils, though their more common place of origin appears to be at the back part of the two upper turbinated bones. They grate under the scalpel, mould themselves at times more or less upon the cavities of the part so as to have a lobulated appearance, but are so firm in structure as to deform the nose and produce pain by the pressure they occasion. Of all others these acquire the largest size, and are most liable to disunite or perforate the bones of the face. They give rise to hemorrhage, and when they become themselves inflamed, are liable to soften and ulcerate, and occasion ichorous discharges, the swallowing or absorption of which may become the cause of death. Their cancerous degeneration is considered rare. In one case Dr. Mott removed two polypi of this description, which were attached to the floor of the same nostril.

* A writer in the Amer. Journ. Med. Sciences, April, 1842, (Dr. J. Watson, of New York,) advocates the same idea as regards the follicular origin of mucous polypi, which idea, he says, "I am happy to find confirmed by the high authority of Garengot, and after him by that of Heister."

The *sarcomatous* or fleshy polypi are less hard than the fibrous, and are usually attached by a broad base, moulding themselves to some extent on the cavities, and deforming the parts as they grow. They are red or brown coloured, and very vascular, the veins being frequently in a varicose condition. They bleed spontaneously or from slight irritation, and give rise when much developed to excessive pain. Next to the fungous polypi, they are the kind most liable to cancerous degeneration. They are usually found near the anterior termination of the nostrils;—in two instances I have found them occupying the side of the septum near the anterior orifice.

Cartilaginous polypi are those of the preceding kind, which, instead of falling into malignant degeneration, have in course of time been converted partly into cartilage or bone. They are rarely met with. Sometimes their more solid portions are mixed up with cysts and hairs, so as to form what has been called by M. Gerdy the mixed or compound polypus.

It is necessary also to observe, that the polypi, and especially those of a gelatinous or medullary character, which spring from the lining membrane of the frontal and maxillary sinuses, are also found not unfrequently to advance so as to occupy the nasal cavities. When the nasal polypi become cancerous, or are of that nature from their commencement, as is believed by some writers occasionally to be the case, they grow with prodigious rapidity, involve the bones, and may be mistaken for malignant tumours of the upper jaw.*

Little reliance is placed in the action of therapeutic remedies for the cure of polypous tumours. The vesicular or mucous polypi, if discovered sufficiently early, may, however,—by the use of astringent or weak caustic injections, calomel and sugar in the form of snuff, or powerful errhines such as the powdered root of *Sanguinaria Canadensis*, etc., by modifying the state of the membrane—be occasionally cured, or at least checked in their growth. Measures of this sort are at least useful in preventing their reproduction after their removal by operation. To facilitate the action of these remedies when employed for the removal of the excrescences, especially when the patient is unwilling to submit to the use of more efficient measures, it is well to follow the practice of the surgeon referred to in a note above, Dr. Watson, and open them freely with the knife, when they will discharge their contents, and shrink into much smaller dimensions.

Cauterization.—The older surgeons made frequent use of active caustics of nearly all descriptions, including the hot iron, and it is probable, notwithstanding the repugnance properly felt against their employment, and the additional resources for the removal of this affection possessed at the present time, that cases may occasionally occur to justify their application. Walther speaks very favourably of the process of an empiric named Jensch, who employed an energetic caustic composed of the butter of antimony, nitrate of silver and sulphuric acid. His practice was to make use of a long pin with a head the size of a large pea; this was covered with the paste and applied five or six times to the prominent part of the tumour. A solution of alum was thrown up an hour previously, and again an hour after the operation. The cauterization was re-

* It is difficult to form a satisfactory classification of nasal polypi. That which I have given will not be found to differ in its leading particulars from the classification of Gerdy, which has generally been well received by surgeons.

peated daily until the tumour was destroyed. Any remains left were touched with the nitrate of silver, and the aluminous injections continued for two months, in order to prevent the re-development of the tumour. To restore the sense of smell, says the narrator, the patient was directed to employ the powder of *napeta* (*teucrium verum*) in the form of snuff. It is by no means unlikely, in cases where the timidity of the patient is such as to prevent

the prompt and efficient extraction of the tumour, that this measure might succeed where the polypus was neither deep-seated, large, nor malignant in its character.

The actual cautery, if carefully applied as recommended by Richter and Deschamps, would no doubt effect the prompt destruction of even large polypi. But the inflammatory symptoms that might follow, and the risk of cerebral irritation, especially

PLATE LII.—NASAL POLYPI.—HARE-LIP.

POLYPI.

Fig. 1.—Removal with the forceps by torsion and traction.—In the process here represented, the surgeon has seized the tumour between the blades of the forceps (*a*), and after having twisted it upon its root, has brought it by a strong traction to the opening of the nostril. In case it should prove too large to be brought out by this orifice, an incision (*b*) may be made for the purpose of enlarging it, as in the manner of Dupuytren, between the ala and the upper lip.

(*Figs. 2, 3.*) REMOVAL BY LIGATURE.

Fig. 2.—Process of Dubois.—The external surface of the nasal fossa of the left side is shown by a vertical section through the head—the septum narium being removed completely with the exception of two small strips. At the period of the operation shown, the three ends of the threads—those of the ligature (*c, c*), that of the coloured thread (*d*), which controls the movement of the segment of the gum catheter—have been drawn out by the anterior orifice of the nostril. The third thread (*e*), designed to draw back at will the loop of the ligature, is pendent from the mouth. The left fore finger of the surgeon (*f*) is passed through the mouth and curved upwards behind the velum palati, for the purpose of carrying the loop of the ligature behind and around the polypus, so as to embrace its root. When this application of the ligature has been effected, the segment of the catheter is to be withdrawn by pulling on the coloured thread. The ligature is then to be tightened by the introduction of a *serre-nœud* or knot-tier over its extremities (*c, c*). If the loop in the attempt is not drawn over the polypus, it is to be pulled back by the third thread (*e*), and the manœuvre repeated.

Fig. 3.—Process of M. Felix Hatin.—The anatomy of the parts represented is nearly the same as in fig. 3. The period of the operation shown is that in which the instrument (*g*) has been carried from the mouth behind the palate, till the extremities (*h*) have reached the top of the palate. All that then remains to be done, is to have the two ends of the ligature (*i, i*) drawn by an assistant over the polypus so as to embrace its root (*k*).

HARE-LIP.

Figs. 4, 5.—Simple hare-lip.—In fig. 4, the rounded margin of the lip is represented as having been removed on the right side of the fissure, and the surgeon, who is placed behind the patient, extends the left margin with his left hand, while he excises the rounded edge with a bistoury in his right.

In fig. 5, the fissure is shown closed after the excision of the edges, by the two hare-lip sutures.

(*Figs. 6, 7, 8.*) DOUBLE HARE-LIP. COMPLICATED HARE-LIP.

Fig. 6.—This shows the state of the parts immediately after the excision of the four edges, two of which (*c, d*) are on either side of the middle line. The central portion is the incisive or intermaxillary tubercle, consisting partly of a bony prominence on the front of the middle incisor teeth, and partly of a thickened mass of gum and skin. This tubercle (*a*) was adherent by its cutaneous surface to the column of the nose (*b*), from whence it has been detached with the knife. The incisor teeth, which had diverged from each other, have been partially loosened in their sockets so as to allow of their approximation with the metallic thread.

Fig. 7.—This represents the forcing backwards with a pair of flat-bladed forceps of the prominent portion of the jaw, in which the two incisor teeth are lodged. This attempt to bring the teeth down to their proper level is commonly attended with slight fracture of the bone.

Fig. 8.—This shows the appearance of the parts at the completion of the operation, after they have been closed with three twisted or hare-lip sutures. The pins are not represented as having taken a sufficiently deep hold. The wrapping of the pins is left incomplete for the purpose of showing better the adjustment of the raw edges.

Fig 6

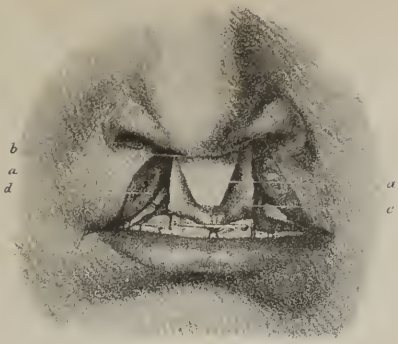


Fig 7

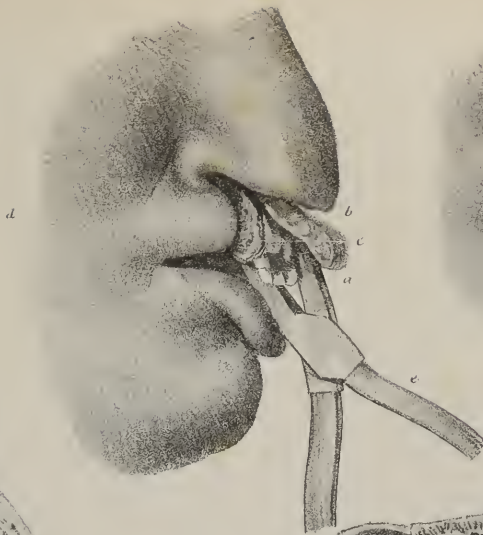


Fig 8

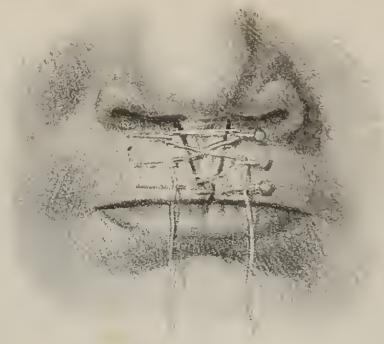


Fig 3

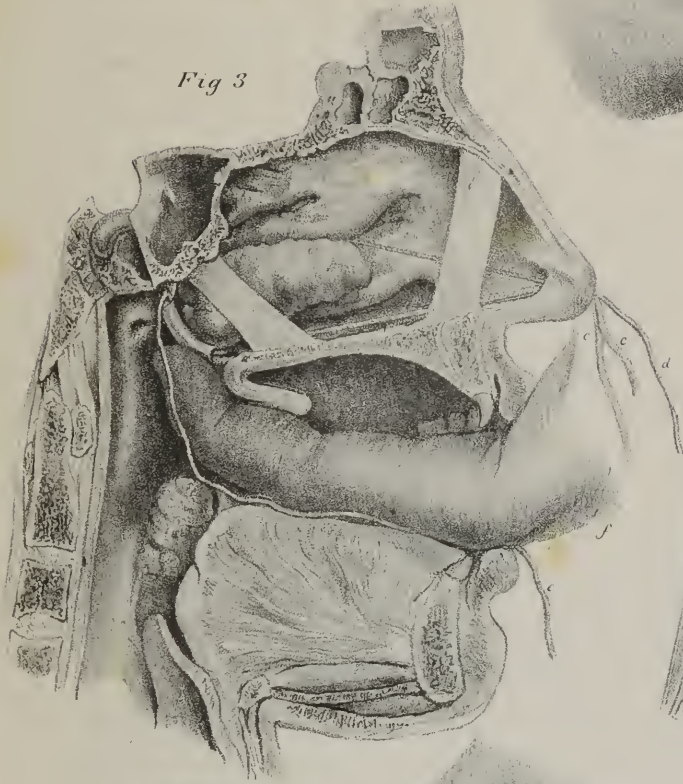


Fig 2

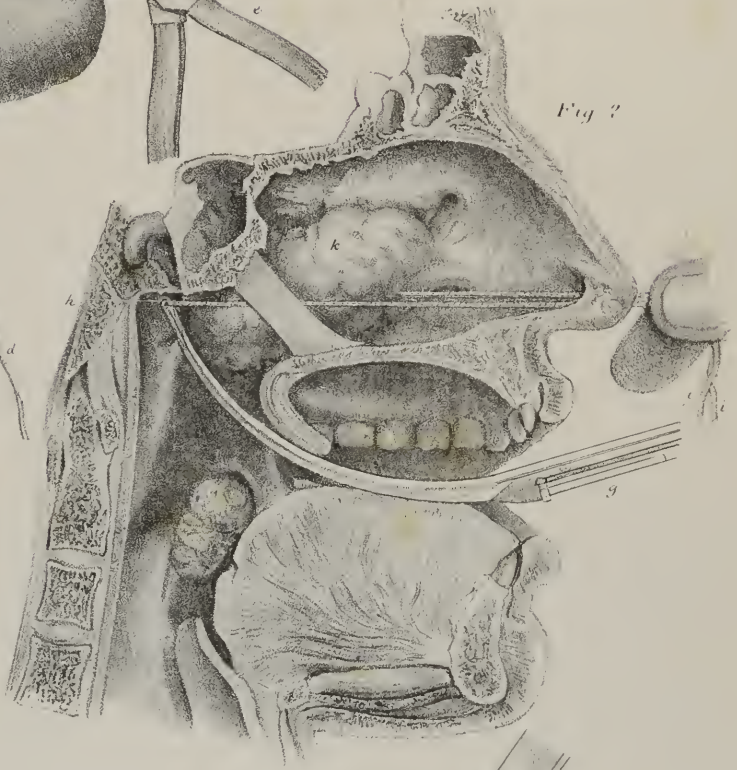


Fig 1

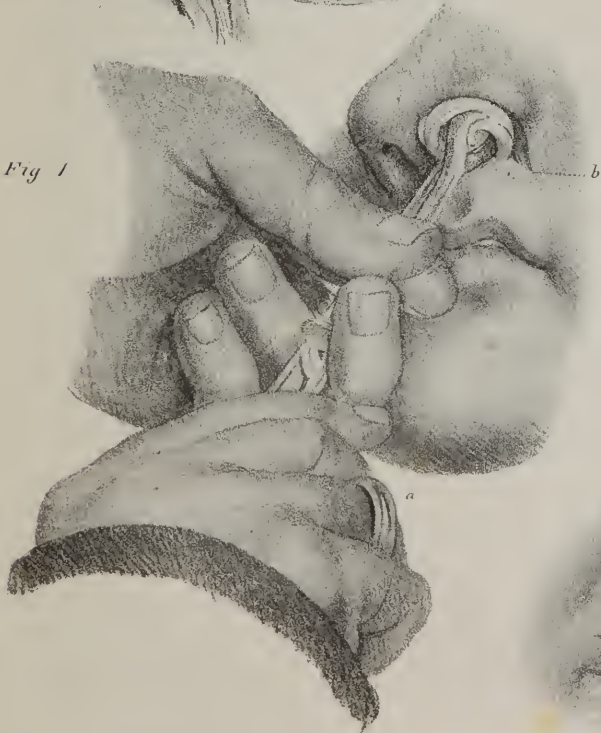


Fig 4

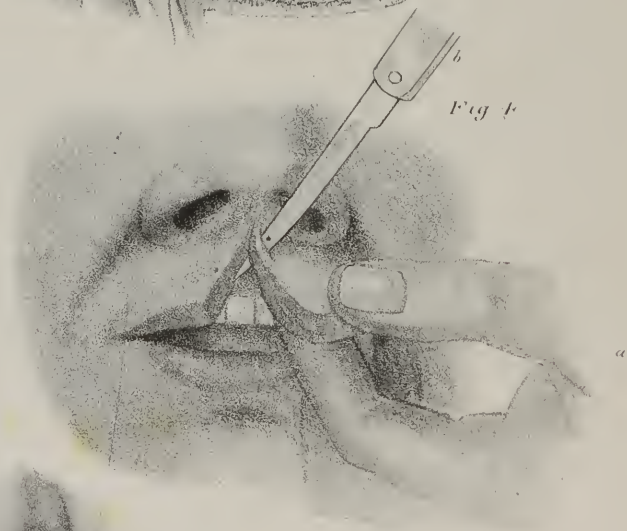
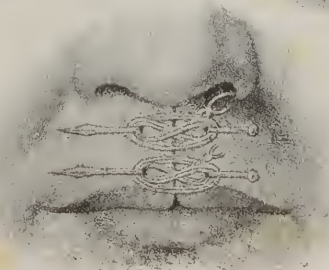


Fig 5



when the seat of its attachment is high, constitute the objections to its application. The use of the hot iron may indeed be considered as limited to the destruction of the basis of the fungous or malignant polypus after the bulk of the tumour has been removed by extraction.

The measures to be relied on for the cure of polypi are *extraction*, *excision*, and *strangulation*.

Before proceeding to apply either of these measures, the operator should determine as nearly as possible the place of attachment of the tumour. If the tumour be pendulous, the individual should be directed to blow strongly through the affected nostril, by which means it will at times be brought forwards so as to be completely in view. For a thorough examination of the passage the patient ought to be placed so as to let a bright light fall upon the inner surface of the nostril, which should be dilated by drawing the ala to one side, by introducing the blades of the dressing forceps, or the funnel-shaped silver canula called the *speculum nasi*. A whalebone or silver probe may then be passed up along the two sides of the tumour, which should be drawn forwards so as to render it tense, in order to ascertain its place of origin. If there is reason to suspect that the tumour hangs from the posterior nares, or is attached near it, the finger may be carried up behind the velum to serve as an exploring sound.

Extraction.

This is the method most commonly used, and is indicated in all cases where the polypus is not too deep seated, nor its basis too broad and firm. It is inapplicable when the tumour is affixed by a strong tendinous root to a soft bottom, as the velum palati; or when its position and extent be such as not to allow the application of the forceps, or a small canula and wire loop.

Extraction may be made by *twisting* the tumour upon itself, so as to rupture its point of attachment. This is called the removal by *torsion*. The twist can only be effected when the straight or slightly-curved forceps are applied, as there is not room in the nostril for the rotation of a curved instrument on its long axis. Extraction may also be accomplished by *evulsion*, grasping the tumour securely, and moving it suddenly either forward or back, and in some instances in both directions. Both these modes may very frequently be combined with advantage.

1. *With a ligature.* (*Process of Theden.*)—It is a process employed by the ancients. Thread the two fenestra of the polypus forceps (which will serve the same purpose as the double ring forceps of Theden), with a strong silk or hempen ligature, and carry them from the anterior naris below the tumour; open them and carry the blades up on the sides of the tumour. The ligature is to be left as the blades are withdrawn behind the tumour, and as high up as possible. A *serre-nœud* or a small cylinder is then slid over the two ends of the string, so as to tighten it on the tumour and allow of the necessary traction. This process is, however, seldom used, for if the forceps can be carried round the tumour, they may also be made to grasp it either for the purpose of torsion or evulsion.

2. *With a wire ligature and the double canula of Levret.* (*Process of Randolph.*)—The ends of a well-annealed iron wire are to be passed separately through the two tracts of the canula, leaving an oblong loop about an inch long in its greater diameter. One

of the ends is to be secured to the corresponding arm of the instrument. The loop should be bent so as to form a slight angle with the canula, and introduced first vertically into the nostril, and then turned upon the floor of the nostril so as to receive within it the pendent portion of the polypus, up which it is to be carried as far as possible towards its place of attachment. By drawing firmly on the loose end of the wire the loop is tightened on the polypus, seldom cutting it even when soft, and furnishes a secure hold for its removal by evulsion. The process is to be repeated till all the tumours are removed, and the passage rendered free. I have seen this process admirably executed by Dr. Randolph, of this city, and it has succeeded well on many occasions in my own hands. In deep-seated polypi this plan may be considered more safe and certain than that with the forceps, as the turbinated bones from their shape cannot be included in the loop.

3. *With the fingers.* (*Process of Morand.*)—This process is susceptible of application only in cases where the polypus is firm and small, and attached by a slender pedicle. The fore fingers of the two hands are to be introduced—one by the anterior and the other by the posterior naris, and the polypus pushed between their ends backwards and forwards till it breaks away at the root; it is then to be removed with a pair of forceps or a hook through the anterior orifice—or by the posterior, if that should be found most convenient. This process is but seldom now employed; but in combination with the use of the forceps the introduction of the finger in the posterior naris may be found highly advantageous, not only in changing the position of the tumour so as to render it more easy to be seized, but in pressing it forwards so as to assist the action of the forceps in rupturing its pedicle.

4. *With the forceps.*—This is the process most commonly employed. It is advised for some days previous to the operation to dilate the anterior orifice of the nostril with sponge tent, gentian root, &c., in order to render more easy the introduction and manipulation of instruments in the passage; but this is a measure to which it is seldom necessary to have recourse. The instruments required will be several pairs of polypus forceps of different sizes, straight or very slightly curved for operation through the anterior orifice, and curved more or less like the letter S for introduction through the mouth into the posterior orifice. Occasionally it will be found most convenient to have at hand the forceps of Josephi, which are formed in separate branches, and are to be applied separately and locked like the obstetric forceps. A good hook, a pair of toothed forceps, a probe-pointed bistoury, a pair of curved scissors, and the apparatus for suppressing bleeding, as described at page 233, should also be at hand.

Whatever process of extraction is followed, it is often necessary to suspend the proceeding from time to time when the patient is fatigued, in order to clear the cavities of the nose and mouth of blood, and give the patient time to recover. If profuse hemorrhage follow, not arrested by the extraction of the tumour at its root, it may become necessary to plug the cavity and defer completing the operation to another day.

By the anterior nares. (Pl. LII. fig. 1.)—The patient should be seated before a window, and the head thrown back, and supported against the chest of one assistant, while the hands are embraced by another. The operator then introduces the blades of

the instrument closed, and with their edges vertical. He carries it onward, using it as a probe to ascertain the seat, size, and direction of the polypus, and opening the blades, grasps it as near as possible to the root. If the polypus be not too large, it should be drawn forwards, and the instrument then rotated several times on itself; if the root do not then give way, it is at the same time to be pulled or jerked forward. If the tumour is large, or for other reasons cannot be twisted, it is to be steadily drawn forwards, and a half turn given to the instrument. If there is much resistance felt in bringing it forward, the fore finger of the left hand should be placed under the forceps so as to give it more effect, or convert it into a lever of the third kind. When the tumour comes out elongated from the nostril, it should be seized nearer its root, with a second pair of forceps, before the first is removed; and if necessary, the application of the instrument may be a third time repeated. If the root then give way, the extraction is effected. If it be too strong to rupture, it will probably be stretched down so as to come in sight from the orifice, and may be severed with the probe-pointed bistoury or curved scissors. If it be so soft as to give way in its middle, the instrument must be again and again introduced to remove the portions left. If from the size of the polypus the resistance is so great as not to yield to repeated strong traction and torsion with the forceps, aided by pressure with the finger through the posterior naris, an attempt to rupture its root may be made by pushing it backwards and forwards, after having mashed and lacerated the root by closing the instrument firmly on it with both hands. If the difficulty arise from the narrowness of the anterior orifice, as in cases of large polypus where the nasal bones have been absorbed, this may be enlarged, as has been done by Dupuytren, Serres and Velpeau, by dividing the ala at its connection with the lip and cheek; or, as has been suggested by Vidal, instead of the ala we may divide the inferior attachment of the septum, which gives as much room as the section of the ala, and leaves no external cicatrix.

By the posterior nares.—When the tumour is situated at the same time in the nostril and upper part of the throat behind the velum, it is to be extracted through the cavity of the mouth. The jaws should then be widely separated, and a piece of wood interposed between the molar teeth. The straight forceps can here also occasionally be used, by preparing the velum a few days previously, so as to accustom it to the contact of instruments, and should when they can be applied, be preferred to the curved, as they admit of the employment both of torsion and evulsion. If curved forceps be used, evulsion alone can be practised, and from the shape of the parts, it is upon these in general that we are compelled to rely, of which several of different forms should be at hand. The left fore finger should be introduced behind the velum, along which the blades of the instrument should be conducted with the other hand, so as to seize the polypus near its root. I found it convenient in one instance, to pass the first two fingers of the left hand behind the velum, so as to get the polypus between them, over which the blades of the opened forceps were readily slid upon the pedicle. If the tumour does not readily yield to moderate traction downward, a spatula may be passed through the nostril from before backward, to aid the effort by pressing against the root. Care must be observed

to avoid injury of the velum, and all pressure upon the root of the tongue, as the latter would be likely to produce vomiting.

By these measures, success will in general be obtained; but if the polypus rest upon the soft palate, and fill up the space behind it so as not to be grasped with the forceps, or has its neck within the posterior orifice of the nostril, it is recommended to split the velum by the side of the uvula, (where it is least vascular,) with the bistoury or scissors. Through the fissure thus made, it will be easy to seize the polypus near its root, or, if necessary, remove it in fragments with the bistoury or curved scissors. After the complete removal of the tumour, the suture of the velum is to be at once made. In one instance I succeeded in removing a large polypus without difficulty, from the back part of the velum, with the improved tonsil instrument, represented at Pl. LV. fig. 6. without the necessity of dividing the velum, which I believe can but very seldom be required.

By both orifices.—If the polypus has grown in both directions, the extraction of the nasal portion through the anterior orifice is to be first made, and the posterior growth removed afterwards as above directed through the mouth.

But in some rare instances, cases are met with in which the polypus attains great size, moulds itself on the irregular surface of the nostril, penetrates either into the antrum by its opening, or through the spheno-palatine foramen, or, by both routes, and erodes and makes new passages in various directions through the bones. For such cases, no prescriptive method can be given; but a combination of the various processes may be made, or new ones devised suited to the exigencies of the case, all which must be left to the ingenuity and the skill of the operator. Dupuytren, and Chaumet of Bordeaux, have succeeded, under circumstances of this description, in dividing the polypous growth and removing it in fragments, partly by the anterior and partly by the posterior nares. In some instances, it may even become necessary to make an incision through the root of the ala of one side, and remove a portion of the upper maxillary and nasal bones in order to get at the seat of the tumour,—as recently done in one instance by Professor Mott.*

Excision.

This is a method at present but seldom employed, though the one most frequently used by the ancients, who devised for its performance particular cutting instruments in the form of a spatula or chisel. Fabricius employed a sort of forceps with a double cutting edge; Wathely a sheathed bistoury or syringotome—but modern surgeons, in the few instances in which they resort to excision, employ in common nothing but the ordinary long-branched scissors curved on the flat, or a probe-pointed bistoury wrapped round with adhesive plaster, so as to leave a cutting surface only near the end.

Excision is only indicated in cases where the root of the polypus is small but unyielding, is accessible to vision or touch, and seated near one of the orifices of the nostril; or when it is employed for the purpose of dividing in pieces a polypus which is so large as to prevent the introduction of any instrument for its extraction or ligature. I have on several occasions removed by excision, sarcomatous or caruncular growths near the anterior orifice, but

* Amer. Jour. Med. Sci. Jan., 1842.

have generally found it necessary to resort to immediate plugging to check the hemorrhage, and the subsequent use of caustic to prevent the reproduction of the tumour.

If the *operation* is practised by the anterior orifice, the polypus is to be drawn forward with a pair of forceps or a hook till its neck or root is visible, which is to be divided with the straight probe-pointed bistoury, guarded as above directed. If the section is made through the posterior nares, and by the mouth, a pair of curved scissors, or the tonsil instrument, as mentioned at page 237, are the only instruments applicable.

Process of Wathely.—In a case of very large polypus with a broad root, this operator first carried around it the loop of a ligature, leaving the two ends hanging out from the anterior nares. One of these ends was held by an assistant; the other he slipped through a ring adjusted to the end of the sheathed bistoury or syringotome, which served as a conductor, so as to enable him to bring the knife upon the pedicle of the tumour and divide it.

By strangulation with a ligature.

This method—after extraction—is the one most commonly employed, especially for hard polypi, which have their seat near the posterior part of the nostrils, and project into the throat. When judiciously employed it will obviate in almost every case any necessity of dividing the velum. The object of the method is to strangle the pedicle by a ligature tightly applied around it, when the polypus, which is nourished from the vessels of the root, sloughs off. Bleeding is effectually prevented by this method, but its execution is always more or less difficult, sometimes even impracticable, and the treatment necessarily protracted and tedious. Occasionally violent pain and inflammation follow. The polypus if it does not, as sometimes happens, separate at once on the tightening of the ligature, swells up in the first place, and in the end becomes a putrid mass—rendering necessary the rinsing of the passages from time to time with cold water, or a weak solution of the chloride of soda, to remove the odour and prevent the offensive fluids from accumulating and passing into the stomach. In order to prevent the more effectually the swallowing of the fluid, the patient should be placed in bed with his face downwards. This position, at the period when the polypus is about to separate, will also diminish the risk of its falling backwards, either into the pharynx or upon the orifice of the larynx. It is also considered proper, when practicable, to pass a thread with a curved needle through the body of the tumour, bringing out the thread and securing it upon the cheek, so that the patient or an assistant can raise the tumour at the moment of its loosening and withdraw it through the mouth. Various instruments and processes have been devised for the application of the ligature, a practice which was known to the Greeks and Arabs. The best of these are the following.

Process of Levret.—This consists in the application of a wire ligature and a double canula, as described for evulsion at page 237, with the exception that the pedicle—which could not be broken without the application of a force that might be injurious—is to be strangled by tightening the ligature from day to day, and leaving the instrument in place, till the separation is effected.

Process of Brasdor.—This is very superior to the process just described. A portion of well-annealed silver wire, eighteen

inches long, is to be doubled so as to form a loop in the middle, and passed through the nostrils till the loop is seen in the back part of the pharynx, from whence it is to be drawn a little forwards, so that a strong thread may be attached to it on the side of the mouth. The two ends of the wires are then to be drawn forwards from the nostril, while one or two fingers glided behind the velum directs the loop round the tumour, so that it may slip up and embrace its neck. If the attempt to catch it fail, the thread from the mouth serves again to draw down the loop, and the manœuvre is to be undertaken anew. When the neck is embraced, the two ends of the ligature are to be passed through a *serre-nœud* or a double canula, tightened firmly on the root and left in place. An additional tightening will be required daily, and in the course of seven or eight days the separation is usually effected.

This process has been more or less modified by various surgeons. *Desault* conducted the metallic ligature through the nostril by means of a canula. *Boyer* preferred either the catgut ligature or a silk cord, which he introduced with the aid of *Belloq's* instrument. *Liston* and others employ in place of the catgut a piece of slender whip cord.

Dubois (Pl. LII. fig. 3.) made use of a stout silk ligature, and devised the following means for getting the loop round the polypus. Previous to introducing it, the end of a gum catheter, from half an inch to an inch and a half long, according to the size of the tumour, is slid over one end of the ligature, so as to rest on the portion which is to form the loop. A coloured thread, for the purpose of distinction, is to be attached to one end of this piece of catheter, and another, uncoloured, to its middle. The uncoloured thread is subsequently to be brought out from the mouth, as in the process of *Brasdor*. The apparatus being ready, an ordinary gum catheter is introduced into the pharynx through the nostril, and its end brought out with the finger through the mouth. To the eyes of this catheter are attached the coloured thread and the two extremities of the silk cord, all which are to be drawn back with the catheter through the nostril. The three ends now hang from the anterior nares, from which the catheter being no longer useful, is to be detached. The surgeon next carries one or two fingers beyond the polypus in the throat, so as to direct the loop behind it, while an assistant draws at the same moment on the two ends of the silk cord and the coloured thread. If the loop meet with firm resistance as it rises up, it has embraced the tumour. If it does not, it is to be drawn down again by the thread hanging from the mouth, and the attempt repeated. When once well embraced, the buccal thread may be cut, and the segment of the catheter, which served the purpose of spreading the loop, withdrawn as no longer of any use, by pulling on the coloured thread. The strangulation of the pedicle is then to be made with the aid of a *serre-nœud* or canula, as in the process above described—the former being preferred to the canula, as the latter is cumbersome, and irritates the nostril. This is an ingenious process, but it has proved in the author's hands difficult of execution.

Sub-process of Rigaud.—In 1829 this surgeon devised a port-ligature, which has been employed with considerable success, and been variously modified by different surgeons. It consisted of three steel branches, curved at their extremity, and enclosed in a

canula, and which admitted of being separated and closed at will. Each of the branches is pierced at its extremity with a hole, continuous with a slit, the sides of which are elastic and yielding. Through these holes or rings is passed the ligature, which is thrown into a loop by the separation of the branches. Bellocq's instrument is to be carried through the nostril into the mouth, and to the button of the stilet the two ends of the ligature are to be attached and drawn with the instrument out of the nostril. As the two ends of the ligature are drawn through the nostril, the port-ligature is carried in its expanded state behind the velum, so as to embrace the polypus in the loop; further traction expands the slit in the elastic rings, so as to detach the instrument and bring the ligature round the root of the polypus.

M. Hatin has modified the port ligature of Rigaud, by making the two lateral steel branches move upon the middle one by a screw, so as to be opened at will. This modification has been many times successfully used.

When the ligature is once fairly applied, the choice of a serrenœud is a matter of some importance, as it is desirable to obtain such a one as will produce the least pain and irritation in the fauces. That of Græfe as modified by Dupuytren will answer well; but the chaplet of Roderick or Mayor is entitled to a preference, as from its flexibility it accommodates itself to the curvatures of the passages.

Whatever method has been employed for the removal of the tumour, the final success of the operation should be tested by causing the patient to blow through the diseased nostril in order to see if the air passes freely, or whether there are any tumours remaining that require to be removed. If the passage is found free, it is an indication that the operation has succeeded in removing not only the tumour itself, but a large part of its root.

CATHETERISM AND PERFORATION OF THE FRONTAL AND MAXILLARY SINUSES.

These are cavities annexed to the nasal passages, and lined by a continuation of the same mucous membrane. From the position of the orifices of communication in the nostril, shown at page 232, it will be readily perceived that a tumour developed in either cavity may encroach on that of the nose, or one developed in the latter, in turn make its way into the maxillary or frontal sinuses.

Frontal sinuses.

These cavities are the more developed in size in proportion to the age of the patient; they are hollowed out in the interior of the internal orbital processes of the frontal bones—those of the two sides being separated by a perpendicular bony septum—which is frequently found incomplete, and placed in most instances in or near the median line. The cavity of the sinus often extends far in the diploic structure of the bone, and has in some instances been found to reach the external orbital process. The orifice by which it communicates with the nose is funnel-shaped, extending down through the anterior ethmoid cells, and may, if occasion requires it, be traversed by a flat probe or catheter. The cavity of the sinus can be reached also by applying the trephine or perforator upon its anterior wall, or upon its inferior or orbital. This is an operation, however, seldom or never required. The ante-

rior wall is thick and covered by the root of the eyebrow; the orbital, though thin and yielding, has passing over it the frontal branch of the fifth pair of nerves, and a small artery, which would be more or less exposed to injury in the use of the trephine. In case of obliteration of the orifice of communication with the nose, it would be possible to restore it by introducing the needle trephine of Weinhold upwards from the nostril into the sinus, retaining the new orifice patulous by the introduction of a piece of catgut string, or the repeated use of astringent injections.

In abscess of the frontal sinuses, the affection to which these cavities are most subject, the pus finds usually after a time a spontaneous passage into the nose. Polypous tumours, which sometimes though rarely form in these cavities, tend naturally to show themselves in the nasal fossæ, from whence, according to Heister, it is possible to extract them. Cases, however, may occur, where this communication with the nose is permanently obliterated, so as to render one of the following operations necessary.

Catheterism.—The channel by which the frontal sinus communicates with the nose is about half an inch long, and runs from above downward and backward, and opens under the anterior extremity of the middle turbinated bone. A flat probe or catheter slightly bent forward at the end and carried in this direction upward and backward, pressing at the same time upon the lip near the root of the septum, may be made to enter the lower end of the channel. Worms sometimes lodge in this passage, and if their presence be detected, some oil or a bitter infusion may be injected through the catheter. If the needle trephine of Weinhold be used, it must be applied in the same direction in which the probe is passed.

Perforation through the walls of the sinus.—This may be made with the trephine or the ordinary perforator. Occasionally a fistulous orifice is found in the bone, which needs only to be enlarged in order that we may wash out by injections the matter of the abscess, or extirpate a polypous tumour. In other cases, it is advised by Velpeau to uncover the bone below the eyebrow, between the groove above the upper margin of the orbit and the root of the nose; and from this point, direct the small crown of a trephine or the ordinary perforator, backwards, upwards, and inwards, so as to open the sinus at its most depending point, and at a place where its walls are thinnest and the vessels and nerves least exposed to injury. The opening, whether made by ulceration of the bone, or by operation, is apt to become fistulous and allow the escape of air from the nose in respiration. Its closure is in consequence somewhat difficult, but may be effected by one of the plastic processes. If the communication with the nostril does not exist so as to allow the discharge of the secretion from the sinus in the usual manner into the nose, it must be established by the use of the probe, and by the injection of fluids, before an attempt is made to close the outer orifice.

Maxillary sinus.

This is a triangular-shaped cavity, occupying the centre of the body of the upper jaw bone, the base of which is turned toward the nasal fossa. In a surgical point of view, it may be considered as bounded by four walls. 1. The internal or nasal, formed by the external face of the nasal fossa, begins half an inch behind the bony border of the anterior orifice of the nostril, a little pos-

teriorly to the tract of the nasal duct, and the nasal process of the maxillary bone. This wall is thin and delicate, and divided into two portions by the inferior turbinated bone;—the inferior portion is formed by the outer wall of the inferior meatus; the upper one by that of the middle meatus, at the top of which, as has been before observed, and immediately under the middle turbinated bone, is the orifice by which the sinus communicates with the nostril. 2. The superior or orbital wall is formed by the floor of the orbit, and is so thin, especially at its back part, where it is traversed by the infra-orbital vessels and nerves, as to offer little resistance to the expansive force of a tumour growing within the sinus. 3. The external wall is on the side of the cheek, and is divided into two portions by the root of the malar process of the maxillary bone. In front of this process is the depression called the fossa canina, about half an inch above the two small molar teeth, in which the external wall is most thin. 4. The inferior or alveolar wall consists only of the breadth of the alveolar ridge; the sockets of the first and second large molar teeth are opposite the lowest point of the sinus, and the roots of these teeth frequently penetrate into the cavity, so as to be separated from it only by its lining membrane.

When the maxillary sinus is distended by a tumour, or cyst, the nasal and orbital walls are the first to yield; the distortion of the former may be such as to push the septum of the nose over to the other side, and that of the latter, so as to protrude the eye upon the cheek. The anterior wall, sooner or later, yields so as to become prominent under the flesh of the cheek, and the inferior, in the end, descends so as to efface more or less the bony arch of the palate. In this way, the cavity of the sinus is often found dilated in all directions, attended most commonly at the same time with softening of the texture of the expanded bone.

Catheterism of the maxillary sinuses. (Process of Jourdan.)—This was first proposed and practised by Jourdan as follows, in a case of accumulation of fluid within the sinus. The patient was seated in a chair with the head thrown back, and sustained against the chest of an assistant. A small silver tube, like that for the nasal duct, but two inches longer and somewhat less curved, was introduced through the corresponding nostril to the under surface of the middle turbinated bone. The point having been carried upon the fold formed by the pituitary membrane lining the orifice, he elevated the wrist so as to press the point outwards and pass it into the cavity. The natural orifice was found in this instance obliterated, as mostly occurs in these cases of retention of the secreted fluids. The tube was left in till the following day, and served both for the discharge of the fluid and the introduction of appropriate injections. It was then removed, and the patient on blowing the nose discharged a large quantity of mucus. By a repetition of these measures, the patient was finally cured at the end of six weeks.

Malgaigne has given the following more precise directions for the introduction of the tube, viz: to carry it obliquely upwards backwards and beneath the middle turbinated bone so as to penetrate to the depth of an inch and a half and on a level with the upper fold of the ala of the nose. Then gliding the beak of the instrument under the turbinated bone, it falls naturally upon the orifice, and by a movement of rotation is made to enter the sinus. But the introduction is always more or less difficult, and some-

times altogether impracticable. The method of Jourdan is therefore in a great measure abandoned, preference being given by a majority of practitioners to the formation of an artificial opening by perforating one of the walls of the sinus.

Perforation of the maxillary sinus.—This operation may be required for dropsy or abscess of the sinus, or in cases of the development within its cavity of polypous, fungous, or carcinomatous tumours. The opening may be made either by the mouth or cheek. The perforation of the nasal wall has been effected, and it is said with good results, by Gooch and Richter, but the process has not been generally adopted. The perforation of the orbital wall has been made by Laugier, as stated at page 189, in cases where the nasal duct was obliterated.

By the mouth.

1. *Perforation through the socket of a tooth.* (Pl. LI. fig. 4.)—This process is indicated in cases of accumulation of mucous or purulent fluids in the sinus, and especially if any one of the molar teeth have been lost or found carious, or the socket itself is in a state of disease. It has the advantage of furnishing an opening at the lowest point of the sinus, but cannot be made sufficiently large for the removal of polypous or other tumours, without the complete excision of one or more of the alveoli with the cutting forceps or the saw.

The operation consists in the extraction of one of the molar teeth, and penetrating through its socket into the sinus with an ordinary trocar or the perforator. On the choice of the tooth to be extracted, there is much variety of opinion. All the molares, however, with the exception of the first, correspond to the floor of the sinus, and if either of these be carious, that is the one which should be drawn. But if one has been previously lost, the necessity of extraction is of course removed. If a selection has to be made, the second small or the first large molar should be removed. Inasmuch as the large molar is more important for the purposes of mastication, *Malgaigne* prefers to take away the second small molar as its removal will be found to yield sufficient room for the use of the trocar, in cases simply of accumulated fluid. To keep the passage open, so as to allow the discharge of the secretion and the injection of simple fluids, a wooden plug, a leaden style, or a canula like that employed for the nasal duct, have been recommended. In my own practice I have seldom found these useful beyond the first few days, except during meal time, to prevent the introduction of alimentary substances, as the passage afterwards remains open of itself, or is easily kept free by the occasional introduction of a probe. The patient is able also to carry the fluid by suction through the sinus, especially when the natural orifice has become free, to more advantage than it can be thrown in by the use of the syringe. When all morbid symptoms cease on the side of the sinus, the orifice may be allowed to close.

2. *Perforation by the external wall.* (Process of *Lamortier*. Pl. LI. fig. 4.)—This consists in penetrating into the sinus between the malar process of the upper maxillary bone and the third molar tooth. The corner of the mouth is to be drawn outwards, upwards and backwards by an assistant, with the blunt hook, or with the finger. The mucous membrane is then to be divided at the point of its reflection from the jaw to the lip, and the bone perforated with a trephine, or with a stout scalpel if its tissue be softened.

The orifice may afterwards be enlarged at will, to admit of the introduction of the forceps and knife for the extraction or excision of tumours, or the introduction of lint, styptics, or cauterizing irons, which are sometimes required to arrest the hemorrhage which follows. If the reflected mucous membrane should prove so redundant as to come in the way, as I have found it in one instance, it may be divided by a crucial incision, and the angles snipped off. This process, however, is but seldom employed.

Desault preferred to penetrate into the sinus by the fossa canina, where the wall is most thin; and a strong knife, in cases requiring the operation, will ordinarily suffice to make the opening. Having denuded the bone by a previous incision above the gum and elevated the lip, he entered the scalpel, and turned it four or five times on its axis to make the opening sufficiently free. When the teeth are all sound this process might be employed in place of extraction of a tooth and perforation through its socket. But in case there be a large polypous or fungous tumour of the antrum, it is unquestionably to be preferred as it allows the opening to be made large, and of an oblong shape, above the roots of the teeth. If further room should be required, *Dupuytren* recommended that a vertical incision through the bone, should in addition be made up to the base of the orbit, along the outer side of the nasal process of the upper maxillary bone.

Process of Stevens.—Dr. A. H. Stevens, of New York,* successfully removed a tumour of the antrum complicated with disease of the floor, in the following ingenious manner. He removed first the second incisor and second molar teeth, then denuded in the usual manner the anterior face of the maxillary bone, which he perforated with a long, slender trocar, as in the manner of *Weinhold*, from the digital fossa through into the mouth at the junction of the palatine processes of the maxillary and palate bones. A delicate saw was next introduced along the track of the trocar, and the bone divided downwards through the empty socket of the incisor tooth. A flexible double hand-saw, made of a clock spring, was then employed to cut the bone downwards and backwards from the place of perforation through the socket of the second molar tooth; thus removing all the diseased portion, and making the section through the sound structure beyond the limits of the disease.

3. *Perforation of the palatine arch.* (*Process of Callisen.*)—This method is only applicable to cases in which a distinct fluctuation is felt through the thinned and softened bone, and where there is a considerable lateral enlargement of the antrum. The opening may be made with the bistoury; very frequently a fistulous orifice will be formed through the arch near the gum, which merely requires enlargement. In a case of this description *Ruffel* introduced a trocar by the palatine orifice, brought it out above the gum on the opposite side of the ridge, and passed a seton through the track. *Nerri* has advised as an ordinary process, the passing of a seton in this manner in cases of abscess or mucous dropsy of the antrum.

By the cheek.

Different processes are given by *Weinhold* for perforation through the cheek. If the object be only to remove collected fluids, the needle trophine is thrust, in the direction of the nose,

* Vide Notes to *Sterling's Translation of Velpeau's Surgical Anatomy.*

through the cheek into the maxillary fossa at a point a third of an inch from the root of the malar process and at the same distance from the margin of the orbit. The instrument is carried by a drilling motion through the anterior wall of the sinus, somewhat obliquely downwards. If the object be to destroy any pseudo-production in the sinus, the needle with a thread previously passed through its eye, is carried in the same manner into the sinus, and pushed on through its cavity so as to perforate the palatine arch a few lines to the inner side of the third molar tooth, the finger of the operator guarding at the time the tongue from injury. As soon as the thread becomes visible, it is pulled out through the mouth by means of a hook. The instrument is then removed, leaving the thread in its track, which is now to serve as a conductor to a strong cord, or a roll of charpie, which is to be smeared with various stimulating and caustic applications, and drawn into the centre of the mass. A small piece of sponge is to be attached to the thread, so as to close the lower orifice and prevent the constant escape of purulent fluids into the mouth. *Molinetti* and others have made a crucial incision of the cheek, in order to expose and open the antrum. But in all ordinary cases this measure, which leaves an unsightly cicatrix, may well be supplied by some one of those already mentioned.

In some instances, however, the bones are found so extensively disorganized from disease seated in the antrum, that all the processes for perforation will be found insufficient, and a resection of the walls of the cavity to a greater or less extent will be rendered necessary. It is impossible, however, to give any general rules for such proceedings—many of which must be conducted according to those laid down for the partial resection of the upper jaw—every case becoming in fact a subject for particular study, in which a modification or combination of the various processes above given may be made with advantage.

IV. OPERATIONS UPON THE MOUTH AND ITS DEPENDENT STRUCTURES.

The organs which form the gustatory apparatus vary much as regards their anatomical structure, as well as in reference to the operations which their diseases or malformations render necessary. They may be arranged for practical purposes into four classes:—The Lips and Cheeks; the Salivary Organs; the Tongue, and the Velum Palati.

OF THE LIPS AND CHEEKS.

HYPERTROPHY OF THE LIPS.

This is usually a congenital affection, without alteration of texture, and is to be considered a faulty conformation rather than a disease. In some few cases it has been observed to follow an attack of scrofula in which the lips have become permanently thickened by interstitial deposit, and may then nearly always be removed by local depletion and constitutional treatment. It pro-

duces a disagreeable expression of countenance, and exists in various degrees more or less susceptible of relief by operation.

1. *Tumour of the mucous membrane.*—This is commonly restricted to the mucous membrane lining the inner surface of the upper lip, but is occasionally met with in the lower lip. It forms a transverse red tumour, extending no further back than the point of reflection of the mucous membrane; it is exposed over the incisor teeth and causes the lip to be more or less reverted upwards in speaking or laughing, producing a deformity commonly known as the double lip. Sometimes the oblong tumour, or portion of thickened membrane, is cleft on its free surface, so as to appear as two separate portions. The excision of this tumour was first practised by Boyer, and has since become a legitimate operation where it is productive of *great deformity*.

Excision.—An assistant standing behind the patient supports his head, and drawing up the commissures of the mouth, reverses the lip so as to expose the hypertrophied mass. The surgeon seizes it with his fingers, or a pair of broad-bladed forceps, and excises it at a single sweep with the straight bistoury or scissors curved on the flat. The bleeding is to be suppressed by holding ice water in the mouth, and the wound usually cicatrizes in a few days. In some instances the healing is only effected at the end of two or three weeks; to avoid such a protraction of the cure, Velpeau has proposed the following modification of the operation, viz., to introduce, before excising the tumour, three or four ligatures through its base, and remove the tumour without loosening their attachments. The threads are then to be knotted so as to close the wound, and removed on the second or third day, when union will be found to have taken place.

2. *Hypertrophy or thickening of the upper lip.*—This enlargement of the lip—usually one of the signs of scrofula and then manageable without operation—is sometimes met with unconnected with that affection. It depends upon a thickening and serous infiltration of the cellular tissue, the enlargement of the sub-mucous or labial glands, and a tumefaction of the mucous membrane. The muscles of the lips are found pale and thin, like those of an old man.

Excision of the tumefied parts for the cure of this deformity was first practised by M. Paillard in 1826, and has since then been several times repeated successfully by different surgeons. One of the commissures of the mouth is to be drawn upwards by an assistant, while the surgeon seizing the other, begins the operation by making a cut parallel with the free border of the lip, so as to remove a sufficient portion of its substance to bring it down to its natural dimensions. The flap is to be dissected back towards the union of the lip with the gum, and cut off horizontally at its base with the knife or scissors, removing the whole thickened membrane with its bed of glands. At first the hemorrhage is abundant; but it comes only from small vessels, and soon ceases spontaneously, from the retraction of the tissues. No dressing is required. As the cicatrization is going on, the cutaneous margin descends, so that the lip gradually assumes a natural appearance.

ATRESIA ORIS.—CONTRACTION OF THE ORIFICE OF THE MOUTH.

This is sometimes a congenital defect; but far more frequently it is the result of unnatural adhesions of the free surfaces of the

lips and the contraction following ulcerated burns, as in a case successfully operated on by Professor Mütter, and reported by him in the American Journal of the Medical Sciences for Aug., 1837; or from the destruction of parts following syphilis, scrofula, or cancer, as in another operated on by the author, reported in the same journal for Oct., 1842, and represented at Pl. LXXIII. fig. 2. In both these cases the restoration of the orifice to its proper size, was accomplished by the process of Dieffenbach described below.

Various plans have been devised for the purpose of preventing the tendency of the raw edges to progressive cicatrization, after the mouth had been restored to its proper dimensions by incisions at the commissures. Most of these processes were attended with protracted suffering, the operation requiring to be several times repeated, and were seldom found more than partially successful.

The following ingenious process of the distinguished Berlin surgeon accomplishes the object more effectually, and is the only one to be relied on when the mouth is contracted to a considerable extent. It consists in the removal of a strip of skin and muscle, preserving the mucous membrane, which is to be turned over so that it may serve as a lining to the raw edges of the divided parts, and act as a bar to cicatrization.

Process of Dieffenbach.—On one or both sides of the narrow aperture, according to the nature of the deformity, a flap two to three lines broad is cut out through all the soft parts except the mucous membrane, which is to be left uninjured. The removal of this piece is best effected with a pair of scissors; the left fore finger is to be passed into the mouth so as to elevate and distend the cheek; the pointed blade of the scissors is then inserted at the margin of the mouth between the mucous membrane and the other structures in front, and in this manner pushed on to the distance to which it is wished to extend the commissure. The parts in front of the membrane are divided by closing the scissors; another incision is then made in the same way parallel with the first; and both are then united at their outer ends with a small semilunar incision. The flap is next to be carefully dissected off from the mucous membrane. The same proceeding is to be repeated if necessary on the other side of the mouth. As soon as the bleeding is checked, the lower jaw is to be strongly drawn down so as to stretch the mucous membrane, which is to be separated a couple of lines further from the cheeks, and then divided through the middle nearly up to the new formed angle of the mouth. Each section of the mucous membrane is then drawn over the corresponding raw margins of the new portions of the lips, and secured to the outer surface by fine needles and the twisted suture. At the angles it should be drawn out and adjusted with particular care to the margin of the semilunar incision, so as to prevent any portion of the two raw surfaces from coming into apposition. All inflammatory swelling is to be kept down with a steady application of cold water. The sutures are to be removed between the second and fourth day. I have employed this ingenious process with entire success, the union of the mucous membrane to the raw edges taking place by first intention, so as to insure the permanency of the oral orifice. I give, however, a decided preference to the common interrupted suture over the hare-lip or twisted, in binding the mucous membrane over the raw borders. In one case I have, after the manner

of Mr. Campbell, employed the bistoury in place of the scissors for the excision of the piece, but did not find it so convenient as the latter instrument.

In that species of deformity, where the lips are altogether destroyed, so as to expose the teeth and maxillary bones, and the lower jaw is immovably fixed by adhesions or surrounding cicatrices, the form of operation required must depend upon the nature of the individual case. The excision of the indurated cicatrices, the division of the adhesions between the jaws, and a judicious transplantation of skin from the neighbouring parts, are the chief means by which we may, in a good degree at least, correct the deformity and relieve the patient.

HARE-LIP. (PL. LII.)

This affection consists in a vertical division of one of the lips, usually the upper, commencing at the free margin, and may be either congenital, or the result of accidental injury. The congenital defect, of which alone we shall treat, is always restricted to the upper lip. There are three varieties of this affection, the simple, the double, and the complicated.

Simple hare-lip consists of a cleft in the lip upon one side, commonly to the left of the median line, extending frequently up into the margin of the corresponding nostril.

In *double hare-lip*, there is a vertical fissure upon either side of the median line, including between them an irregular and somewhat triangular shaped portion of the structure of the lip.

Complicated hare-lip consists of a single or double division of the lip, with a cleft of the corresponding part of the upper jaw and palate so as to unite the cavities of the mouth and nostril; or of a double fissure of the lip and the development of an osseous tubercle on the front of the jaw, from which grow irregularly the incisor and sometimes the canine teeth. The tubercle has received the name of the incisive or intermaxillary tubercle, from its occupying the position of the bone of that name in quadrupeds.

Operations for simple hare-lip. (Pl. LII. figs. 4, 5.)—The object of the operation is to unite the edges of the fissure with as little remaining deformity as possible. In former times an attempt was made to effect this by removing the edges by the application of caustics or the use of the knife and scissors, and the approximation of the sides of the fissures with bandages, stitches, sticking plasters, and double-hooked forceps, of various descriptions. All of these measures, however, have given way to the more modern process of merely adjusting the raw edges after incision, with the twisted or hare-lip suture.

Age at which the operation should be performed.—This is a point mooted by the older writers, and which is not yet so well settled as to lead to uniformity in practice. Dionis, Lassus, Sabatier, etc., deferred the operation till the child had reached its third or fourth year. Sharp, Ledran and Heister, advised its performance from a few days to a few weeks after birth. Between the ages of two and four years, children are found so indocile, and so apt, however closely watched, to pull upon the sutures and disturb the process of union, that a great proportion of modern surgeons have with good reason recommended the performance of the operation between the second month and the second year

after birth. I have on several occasions operated within the shorter period, when causes have existed to render it particularly desirable, and the cases have done well—complete union taking place even when the child after the operation had been continued at the breast. The author gives a decided preference to the period under six months, as we then avoid the necessity of having to extract any deformed teeth, and are less likely to be troubled with the irritation attendant upon the teeth making their way through the gums, which acts unfavourably on the union of the parts.

Instruments required.—1. *For the excision of the edges.*—Two instruments are employed for this purpose, the bistoury and the scissors, either of which answers perfectly well. The use of the bistoury is the more ancient, it having been employed by Severin, Louis, and Percy. Excision with the scissors has been objected to as being more painful, and leaving a wound slightly contused and less readily disposed to union by first intention; but the falsity of this assertion has been clearly shown by the experiments of Bell and Desault. In my own practice, I give a preference to the scissors in these cases, and all analogous ones where soft and flabby edges are to be removed. When there is a deficiency of structure, and the margins of the fissure are disproportionately short, scissors curved on the flat will be found the most convenient, as they enable us, by making the incision concave, to increase the relative length of the raw surface, so as to prevent after the cure any depression at the middle of the free border of the lip.*

2. *Reunion of the edges.*—For this purpose, pins will be required, and waxed threads for wrapping them, of the kind ordinarily employed in the ligature of the arteries. It is little important of what material the pins are made, (vide p. 27,) provided they are not too large, so as to cause compression of the substance of the lip, or so dull at the point as to contuse it in their introduction. A hook or a pair of dissecting forceps, which will be convenient for seizing the margins of the lip, and a pair of cutting pliers for removing the projecting ends of the pins after their application, complete the apparatus. Strips of adhesive plaster and some small compresses should also be at hand, as their application may in some cases, when there is great tension upon the pins, be thought advisable.

Operation. Excision with the scissors.—The patient is to be seated in a good light, with the arms and feet well secured, and the head pressed against the chest of an assistant, who with his hands compresses the facial artery of each side under the edges of the jaw, and with the thumb pushes the cheek in toward the middle line. The surgeon sits or stands in front. If the frenum of the lip descend too low, it is to be separated from the gum with a bistoury. The left angle of the lip is then to be grasped with the thumb and forefinger, and the whole of the rounded edge on the side next the fissure removed with the scissors, to a point a sixth of an inch above the top of the cleft. The right angle of the lip is next seized with the hooked forceps, and its margin similarly excised by placing the scissors on the outer side of the forceps, and cutting up to a point, which should be about

* To prevent the occurrence of this depression, M. Malgaigne has recommended, that the strips detached from the borders of the fissure, should be left adherent at their labial margins, and after being shortened to the requisite extent, attached to each other horizontally by suture. But no advantage has arisen from this measure, in the few cases in which I have seen it employed.

a line below the top of the first incision, so as to give without any contusion or laceration an acute angle to the wound. The entire rounded edge should be taken off by these incisions, so as to leave a broad surface for union. The excision should also extend well down upon the labial edges. In these cases, the mistake most frequently committed is that of not making the cut of sufficient length. A sponge wetted in cold water should now be applied to the raw edges to remove the clotted blood and diminish the capillary oozing. The hare-lip pins are then to be introduced, and wrapped with the ligatures as described at page 27. Two, three, or four pins may be employed, according to the length of the wound. The larger the diameter of the pins, the fewer does it answer to introduce.

The capillary oozing and the bleeding from the divided coronary arteries usually cease when the raw edges are fairly placed in contact. The ligatures, however, should not be drawn tighter than is necessary merely to accomplish this object, as otherwise, from the slight inflammatory swelling that follows, they will irritate and cut into the parts by ulceration, so as to diminish the chance of union. If there be a considerable jet from the arteries, as is sometimes the case in large children, one of the pins may be introduced behind the open orifices, so as to compress them when the ligature is applied.

If the operator prefer to excise the edges of the fissure with the bistoury, he places himself behind the patient, and if it be a child, takes its head between his knees. He then extends the margins of the fissure with his left hand, as shown at fig. 4, entering the bistoury with the back to the nose, and cutting from above downwards.

Double Hare-lip.

The mode of proceeding in the cure of this variety of the deformity will depend upon the size of the intermediate part. If it be less than a third of an inch broad, and thin, it should be excised near its base, and the operation proceeded in as in ordinary cases of simple hare-lip. If the intermediate substance be of larger dimension it must be preserved, as it will be of great importance in the reconstruction of the lip. If there is no particular deficiency of structure in the lip, the operation may be completed at once, very much as in ordinary cases of single fissure—by detaching the frenum, paring the edges of the middle portion so as to bring them to a sharp angle below—excising the margins of the two lateral portions—and introducing the pins so as to bring fairly together the four raw surfaces, causing one or more of them to traverse the middle portion. If the middle portion, as is very commonly the case, should not be long enough to reach the labial margin, the wound left after the introduction of the hare-lip pins will have the shape of the letter Y. When the middle portion has not been long enough for this purpose, but unusually thick, the author has in some cases derived advantage by detaching it from the sockets of the teeth, splitting it on the raw surface from above downwards to near the free margin, and straightening the fold so as to increase the length of the piece. In case there be such a state of the parts that the four surfaces cannot be brought together without applying so much tension with the threads as to make them act as a dividing ligature, (vide page 34,) it will be more prudent to unite the parts by two sepa-

ate operations at an interval of two or three weeks, excising two of the adjoining edges, and uniting one of the lateral fissures at a time. It will be particularly well to observe this precaution provided there be any bony tubercle over the roots of the incisor teeth, giving an undue prominence to the front of the jaw. Any deformed or prominent teeth, which would be likely to irritate the margins of the divided surfaces, must be extracted, or, which in some cases of slighter deviation might answer, modified in their position by a twist of the forceps. If the point of the nose should be adherent to the middle portion, so as to cause a flattening of the organ, it is to be detached at the time of the operation with the knife, or at a subsequent period as practised by Dr. J. R. Barton, by embracing it with a ligature, which should be tightened from time to time till it cuts through.

Complicated Hare-lip.

As a complication of hare-lip, especially the form last described, we often meet with a congenital fissure extending backwards from the surface, separating the two maxillary and palate bones, and running downwards so as to divide the velum. The fissure of the velum and the lip may co-exist without that of the hard palate—but when the hard palate is divided a birth, it is found attended with fissure of the velum. The fissure of the hard palate is always in the median line; that of the lip to one side, and terminating in one of the nostrils, most usually the left.

Sometimes the complication in cases of double hare-lip consists merely in the projection from over the roots of the front teeth, of a thick, bony tubercle, called the incisive or intermaxillary, which is covered with a thick, hardened mass of gum and skin, and has on its lower border the teeth irregularly developed, standing frequently directly forward. In some instances we find existing, with the tubercle, a fissure through the hard palate, which may open by a single cleft in the alveolar ridge—or by two, which branch so as to include the tubercle between them.

The mode of operation must be varied according to the nature of the defect. If there is but a single cleft through the palate, without any strongly marked incisive tubercle, the common operation for double hare-lip is all that is required. Experience has shown, that in these cases the early closure of the divided lip gives a disposition to the palate bones to approach each other as the growth of the face goes on, and thus narrow down or even close the fissure, which, without the union of the lips, has a tendency to increase in size. In my own practice I have preferred in these cases, when I have had the choice of time, to operate within the third month. To facilitate the approximation of the sides of the fissure, M. Roux has advised the application of pressure by an apparatus over the malar bones, and Velpeau upon the two sides of the dental arch. I have contented myself with directing the pressure over these regions to be daily made with the hands of the nurse, a measure which has apparently been attended with benefit. The closure of the fissure in the soft palate must be deferred till the child arrives at such an age as to comprehend the importance of the operation, and allow of the free use of instruments in the cavity of the mouth. In case the incisive tubercle is large, the operation is more complex. The teeth in these instances, if the child is over seven or eight months old, will usually have a vicious

direction. It is usually advised to remove them; but in case they belong to the permanent set, it has been latterly the practice to force them by means of a silver wire into their proper position, loosening them in their sockets if necessary for this purpose with a pair of forceps. There are four processes of operation in these highly complicated cases.

1. *Ancient process*.—This consisted in the removal of all the prominent portion of the tubercle with a pair of cutting pliers, and the closure of the fissures in the lip either immediately or a few days subsequently by the ordinary operation for hare-lip. By this process the incisor teeth were removed, and when the two sides of the jaw were approximated so as to diminish the space, the upper was found so much smaller in its arch than the inferior, as to interfere seriously with mastication. This result led Desault to the institution of the following process.

2. *Process of Desault*.—This surgeon, instead of excising the tubercle, forced it backwards to its proper level, by compression with a bandage steadily kept up for eighteen days, and subsequently closed the opening in the soft parts. This measure is not likely always to answer, and has proved ineffectual in my hands.

3. *Process of Dupuytren*.—The following process was applied by this surgeon in the more ordinary cases, when with the prominent incisory tubercle, the middle labial portion stood in an upward direction, viz: to separate the labial from the bony tubercle with a knife, and turn it with its raw surface upwards, and attach it by two points of suture to the lower edge of the septum narium—which is usually imperfect in these cases—after excising the cutaneous covering of the latter. The remainder of the operation consisted in removing the bony tubercle with the cutting pliers, and uniting the lateral portions of the lip as in ordinary cases.

4. *Process of Gensoul*. (Pl. LII. fig. 7.)—This consists in the dissection of the soft parts from the outer face of the tubercle, and reflecting them towards the nose, and then slowly forcing by the application of a pair of flat-bladed forceps, the projecting portion of bone down to its proper perpendicular direction. The canine teeth if deviated are to be removed. The fissures of the lips are then to be closed immediately, in the usual manner, as shown at fig. 8. This process has in several instances proved successful, but is not unattended with danger. In one instance where there was difficulty in depressing the prominence, the author has known a vertical section made with the saw upon its sides, and the prominence depressed with such force as to fracture the bone. The case terminated fatally.

No dressings after the operation for simple or complicated hare-lip will in general be required, as they have a tendency to heat and irritate the parts, and dispose them rather to suppuration than union by first intention.

After-treatment.—The patient should be kept in a state of perfect repose, and avoid, as far as it is practicable, all movement of the jaws for the first three or four days. If a child, it may be necessary to quiet it with anodyne, and to examine carefully if there be any hemorrhage from the back part of the united surfaces, which, when it has existed and been kept up by the suction efforts of the child, has in some few cases been the alleged cause of death. The bleeding arises from the raw edges not being properly con-

fronted on the mucous surface, to obviate which, as well as to facilitate the process of union, the pins are directed to be entered in the operation so as to cross the line of the wound at the junction of the anterior two-thirds with the posterior third of the lip.

Drinks.—Liquid aliment alone should be allowed, and should be introduced into the mouth after depressing the lower lip, with a spoon or some vessel of a convenient shape. On the third day, the upper or one of the middle pins should be removed, and on the fourth or fifth, the remainder. The pins should be loosened by a slight rotation before an attempt is made to withdraw them. If there has been no suppuration from the wound, and the ligatures remain adherent by the coagulation of the blood of the operation, they are to be left undisturbed till they loosen spontaneously, when their place is to be supplied by a strip of adhesive plaster. But if, at the time of withdrawing the last pins, the coils of threads are either loose or infiltrated with a dried mixture of pus, blood and serum, they should be at once removed and the new union of the lip protected by a strip or two of adhesive plaster nicely adjusted. In case the new union should be broken up by accident, or from being left in a fretful child unprotected by an adhesive strap after the removal of the pins, the operator will generally succeed in causing them to adhere a second time by the use of the strips of adhesive plaster, and must on no account recur to the use of the pins till the inflammatory consequences of the first operation have subsided, when the edges are to be again excised.

CANCER OF THE LIPS.

Cancerous tubercles and cancerous ulceration are very commonly met with in the substance or at the free border of the lips; the lower lip, however, being by far most commonly the one affected. If the tumour be small and movable, it may be removed as in ordinary cases by simple excision. If the degeneration extend so as to involve merely the free border of the lip, it may be removed, if very superficial, by cauterization; or if deeper, by excision of the free edge, which is afterwards to be allowed to fill up by granulation. But if the substance of the lip is more generally involved, or the maxillary bone affected, it will be necessary in the one case to extirpate so much of the lip as to render it necessary to supply its place with a new one, by one of the various plastic processes, and in the other to resect in addition the affected portion of the bone.

Cauterization.—Various caustics have been employed in superficial degeneration of the skin or mucous border of the lip. The arsenical paste so strongly recommended by A. Dubois and Dupuytren, and that of the chloride of zinc introduced by Canquoin, (see page 22,) are the caustics most commonly preferred. Dupuytren used the arsenic in the form of powder as well as paste;—his powder was composed of four to six parts of arsenious acid, with ninety-six to ninety-four of calomel.

The treatment of superficial cancer of this part by caustic applications, and especially by the arsenical paste—which has always been more or less in favour with the profession—has latterly been much employed by Fleury, Chelius, Heyfelder, and various American and British surgeons. The author has employed it with advantage in cases of degeneration of the cutaneous and mucous surfaces merely, and to such cases he believes it should

be strictly limited when relied on solely for the cure. The operation by excision is so successful *when early employed* in accomplishing a radical cure, that it is unwise when the substance of the lip is affected, to tamper by any protracted course of treatment with a disease which is so speedily disposed, after the mucous membrane becomes involved, to affect the neighbouring lymphatic glands, and render every method of relief unavailing. After extirpation, and when all hemorrhage has ceased, the caustic may in some cases be used with advantage, in order to sear any portion of the surface in which there is particular reason to fear a return of the affection.

Excision in form of V.—In cases of small tubercle, or where the ulceration of the border is of limited extent, the diseased portion may be removed by a \vee incision, with its base towards the free margin, and the apex directed either to the chin, the cheek, or nose, according to the position occupied by the tumour. The incisions must be carried beyond the limits of the disease, which must be wholly extirpated with the piece removed. They may be made either with the sharp-pointed bistoury entered so as to cut towards the mouth, or, which answers nearly as well, a pair of good cutting scissors. The raw edges are then to be closed with the twisted suture, as in ordinary hare-lip operations.

Excision in form of a crescent \smile .—The removal of the margin of the lip by a semilunar or crescentic incision, is particularly applicable to cases in which the free border is extensively affected by a superficial cancer. The incision may be made either with a pair of curved scissors, cutting from one commissure towards the other, or with a bistoury. In many cases the latter will be decidedly preferable, when for instance it is desirable to remove the central substance of the lip deeper than either the cutaneous or mucous surfaces. This may be readily accomplished by raising the diseased margin with a pair of toothed forceps, and making two elliptical incisions with the bistoury—one on the inner and one on the outer surface, meeting in the substance of the lip; the wound is afterwards to be closed by suture, so as to effect union by first intention. When the free border is simply excised, and no portion of great vertical depth removed, the skin and mucous membrane should be united by interrupted suture over the bleeding surface. By this plan we obtain a much more rapid cure and a more even margin than when the wound is allowed to close by granulation and cicatrization. Though an unseemly gap in the lip may remain for some time after the operation, it will usually be found in the course of a few months surprisingly diminished by that sort of natural modeling process, aided by the contraction of the surrounding muscles, by which an interstitial deposit of lymph raises a depressed surface of the kind nearly to its ordinary level. Dupuytren and Richerand were under such circumstances in the habit of dressing the raw margin, so as to allow it to granulate. This would be necessary if a large portion were removed. Even where the lip has been excised in its whole extent they have confided the cure to the process by granulation, and have under such circumstances seen the cicatrized margin, covered by the reverted mucous membrane, ultimately rise as high as the root of the teeth. But this is a result which does not generally follow; the saliva dribbling over the part prevents healthy granulation and retards the interstitial growth, and a breach remains which impairs the voice, and compels the patient to keep it cov-

ered with an apparatus, for the purpose of arresting the flux of the saliva. Under such circumstances it is best at once when the excision of the entire free portion of the lip is practised, to resort to a restoration of the part by one of the plastic processes. (Vide Cheiloplasty.)

ANCHYLOSIS OF THE LOWER JAW.

The closure of the lower jaw may be only partial, and movable within narrow limits, or it may be complete and perfectly rigid. This arises from a variety of causes. 1. From a destructive mercurial or syphilitic ulceration of the gum and cheek without exterior opening, which leaves these parts in the end firmly united together by broad and resisting cicatrices—the masseter, from want of use and partly at times from having been involved in the disease, becoming rigid and unyielding. Cases of this sort are susceptible of cure by operation.

2. From a similar destruction and morbid adhesion of parts, complicated with a loss of a portion or of the entire substance of the cheek. Besides the usual operation for ankylosis, cases of this description require a plastic operation for the closure of the abnormal orifice. The various modes by which this may be accomplished will be detailed in part IV. of this work.

3. When there is a true bony ankylosis of the temporo-maxillary articulation and limited to this joint. In such instances no measures of relief have been attempted beyond that of removing some of the teeth, for the purpose of facilitating alimentation. But it admits of a question, whether in cases of limitation of the affection to one articulation, it would not be feasible to establish a false joint by a section of the neck or condyle, a measure which has been suggested by Dr. J. R. Barton.

I was consulted two years ago by a gentleman from Tennessee, in reference to an ankylosed condition of his jaw, complicated with a most extensive destruction of the cheek and bone—the result of gangrene from the use of mercury in the earlier part of his life. The posterior alveolar processes and part of the ramus of the lower jaw of that side had been destroyed, as well as all the superior back part of the upper maxillary bone, a part of the ethmoid, and the whole of the bones forming the inferior floor of the orbit, so as to allow the ball of the eye (in which vision was lost) to drop down below its proper level, where it remained hidden in a great measure from view. The jaw was rigidly ankylosed, and the individual was obliged to feed himself exclusively through a huge cicatrized opening that occupied the original site of the cheek, and exposed to view the extensive cavity formed within by the destructive ulceration. The palate, however, was unimpaired, and when the abnormal orifice was closed, the patient could speak distinctly. The case, as is apparent, was beyond surgical relief—other than the adjustment of a nicely fitting, movable metallic plate, which should close the opening and restore the proportions of the face.

4. Ankylosis depending upon rigidity or permanent contraction of the temporal and masseter muscles, without bony union or fibrous adhesions. Cases of this description may arise, when in consequence of disease about the temporo-maxillary joint, or from the presence of a tumour involving the muscles, or impeding the movement of the jaw, the muscles have remained so long in their state of contraction as to become retracted, and keep

the jaw rigidly closed. Instances of this sort, though not of very frequent occurrence, have been reported by Bonnet, Cruveilhier, Waler, Kunholtz, and various other surgeons. They appear to occur quite as frequently in this country as elsewhere, four cases having presented themselves in my own practice. If not found susceptible of relief by the use of warm douches, frictions, and mechanical means of dilatation, it will be found necessary to make a section of the temporal muscle alone, or of that in conjunction with the masseter; the proper processes for the performance of which will be found under the head of subcutaneous operations. After the section of one or both of these muscles, the use of a screw dilator will nevertheless be required not only at the time for the purpose of forcing the jaws, but for a long time subsequently to overcome the tendency of the parts to contract anew.

Operations for the relief of cases of ankylosis belonging to the first class.

Simple dilatation.—Attempts have been made to dilate the jaws by the use of sponge tent, or wedges of wood, gradually increased in size in cases where the jaws could be slightly opened, so as to admit of their introduction. Little permanent benefit has resulted from the use of such means alone, so great is the resistance offered to the distension by these cicatrices, and their tendency to shorten again even when once stretched.

Section of the adhesions and cicatrices.—It becomes necessary to divide these bands, or to excise them completely, which in my own practice has produced the most successful and permanent result. If the jaws admit of any separation, they are to be kept asunder as far as possible, with a spring speculum, or the dilator of Heister, or with a wooden wedge. The dilator of Heister is, to some extent, an objectionable instrument, as it presses on the teeth in such a manner as to be apt to loosen or dislodge them—an imperfection from which the speculum is entirely free.

Process of Mighels.—The patient is to be seated in a chair with the face turned to the light, and the lips widely separated by assistants. The operator glides flatwise a long, narrow, double-edged bistoury between the cheek and the alveolar ridges, as far back as, and if possible behind, the angle of the jaw, and carefully divides the indurated mass from its attachment to the gum. He then turns the edge of the knife outward, so as to cut completely across and as far back as possible, the central portion of the prominent cicatrix, carrying the knife through into the healthy tissue on its outer side. The operator is now enabled to separate the jaws a little so as to introduce the speculum or screw dilator between the molar teeth. With one of these instruments, the jaws are to be separated to the natural extent, and the space gained preserved by the introduction of a wedge of a soft wood between the back teeth of each side. The cheeks are to be kept separated from the gums, so as to prevent any reunion of the divided parts, by the interposition of a small piece of lint or a pledget of linen. The forcible separation of the jaws should be persevered in for the first week steadily, with the occasional use of the dilator, and continued at intervals for two or three months—otherwise, the surgeon may have the mortification, after the incisions in the cicatrix have healed, of finding the rigidity return.

This method, however, in cases of extensive cicatrices adherent to both jaws, will not be found to answer. It failed completely

in the hands of an intelligent surgeon of this city, in the case of a young lady from Delaware, in which I obtained complete success by the adoption of the following measures in addition to those above directed. I made a third section of the cicatrix at its point of connection with the upper jaw, and completely dissected out the prominent fibrous band, which had been divided into three portions, and carried the knife back on the outer side of the ramus of the jaw, so as to detach from the bone a part of the anterior insertion of the masseter. The jaw then yielded with the application of moderate force by the screw dilator. In three other instances I have been equally successful. A thorough division of the masseter cannot, however, be readily made from the mouth, nor is it usually desirable. The chief muscular resistance to the dilator is made, as will be obvious from inspecting its manner of insertion, by the temporal muscle. In cases in which I could not otherwise succeed in obtaining a good separation of the jaws, or at least without the application of force that would endanger the bone or the alveolar processes, from which the gums are usually found to have receded in these cases, I should not hesitate to make a subcutaneous section of the temporal muscle on the affected side. A complete section of the masseter would I believe rarely be necessary. It is advisable to touch daily with a solution of lunar caustic the wound left by the removal of the cicatrix, in order to prevent the growth of fungous granulations.

Excision of the cicatrix through the cheek.—Tenon recommended, in order to prevent the return of the rigidity, to extend the oral orifice by an incision carried from the mouth out through the thickness of the cheek, in order to facilitate the employment of a lever or dilator. Dr. Mott has had recourse to the same process; he moreover allowed the edges of the incision to cicatrize separately, and, after the motion of the jaw was rendered free, removed the cicatrized borders, and united them with the hare-lip suture. But such a proceeding, which entails a visible deformity, can I believe be but seldom necessary.

SALIVARY APPARATUS.

SALIVARY FISTULA. (PL. LIII.)

Salivary fistulæ are the consequences usually of wounds, ulcers, or abscesses. In some few instances they have been occasioned by the development of a calculus in the duct. They consist of an opening on the surface, which communicates within, either with the duct of Steno in some part of its course, as is most common, or directly with the substance of the parotid gland.

Fistulous opening in the duct of Steno.—*Surgical anatomy.* (Pl. LIII. fig. 1.)—This duct is rather less than a line in diameter; its walls are composed of two membranes, the outer one of which is thick and cellulo-fibrous, and the inner formed by a prolongation of the mucous membrane of the mouth. It leaves the anterior portion of the parotid gland at the junction of the upper with the middle third of this organ, and opens into the mouth opposite the second large molar tooth of the upper jaw. Its buccal orifice is without any valvular fold of the lining membrane. Its course is nearly in the direction of a line drawn from the lobe of the ear to the front incisor tooth of the upper jaw, as designated by Dr. Physick. The precise point at which it leaves the gland, is di-

rectly in the course of a line drawn from the anterior orifice of the nostril to the end of the lobe of the ear. It crosses the anterior portion of the masseter muscle, covered by the skin and subcutaneous fatty matter, and attended by a small branch of the transverse artery of the face and a branch of the facial nerve, which runs at the distance of a line below it. It dips towards the mouth round the edge of the masseter and over the facial vein, and after traversing the mass of fat at this point, opens into the mouth through the buccinator about a quarter of an inch in front of the anterior edge of the masseter.

Remarks.—The facility and success of the treatment, as well as the choice of the method for the cure of a fistula of this duct, depend much on the fact of the orifice being the result of a wound or a recent ulcer; or if it be of long standing, whether the skin is healthy or diseased at its margin, whether the passage of the duct on the inner side of the fistula is open or closed, or in fine, whether the fistula is situated anteriorly or posteriorly to the edge of the masseter.

The various processes for the treatment of the fistula, may be classed under four methods, according to the objects they are designed to fulfil, viz., 1. Those for cicatrizing the fistulous orifice. 2. For dilating the inner portion of the natural duct, which in a fistula of long standing is usually found diminished in its diameter, or entirely obliterated. 3. For establishing a new opening into the mouth, or forming a new portion of the canal, where a part of the old has been completely obliterated. 4. For producing atrophy of the parotid gland, when all measures fail to restore a passage for its secretions.

1. *Cicatrization of the fistulous orifice.*

This method presupposes that the fistula has been produced by some temporary cause which has ceased to act, and that the passage which leads from the diseased opening in the mouth remains free and undiminished in size. And if such is not the case, it will be necessary before attempting to close the orifice, to dilate the passage by one of the processes belonging to the second method.

a. By the twisted suture.—In case of a recent wound, the twisted suture and a compressing bandage may be at once applied. The author has in two instances succeeded in such cases in effecting complete union without interruption of the duct, merely by the use of adhesive straps and a compressing bandage, as in the treatment of a common incised wound. But if the fistula is of long standing, the cicatrized edges must be first excised. Percy, Flajani, and Zang, direct that the pin should be introduced through the integuments vertically rather than crosswise.

b. By cauterization.—This may be done with the ordinary caustic articles, or by an application of the hot iron to the edges of the orifice so as to produce an eschar. Before the eschar, which for the time stops up the external opening, has been detached, the saliva is said in several cases reported by Louis, Langenbeck, and others, to have resumed its natural channel, the cure becoming permanently effected through the closure of the wound by the granulations that sprung up. Gensoul, however, has failed under similar circumstances, and is disposed to think that in these cases a fistula of the gland itself has been mistaken for one of the duct. In the former case, cauterization is known to every surgeon to be an efficient process.

c. By compression.—The cure of the fistula, both in recent and old cases, has been sometimes attempted by compression of the duct between it and the gland. This is a painful and unscientific process, certain to produce an inflammatory swelling of the gland, and even if successful in arresting the flow of the fluid through the orifice for a sufficient space of time—fifteen to twenty days—to allow it to close, is liable to lead to permanent obliteration of the duct, and the abolition of the function of the gland. Maligne has proposed a simpler process, the efficacy of which has not, however, been tried; viz., the application of a piece of gold leaf, fastened by pitch, and covered with a piece of court plaster, for the purpose of offering a barrier to the saliva, and turning it into its natural channel, in the hope that under this covering the orifice might close.

2. *Dilatation of the natural passage when this is found contracted.*

Seton. Process of Morand. (Fig. 3.)—This consists in the introduction of a seton from the buccal orifice. For this purpose the inside of the cheek is to be turned out as far as possible, in order to expose the buccal orifice, into which the lachrymal probe of Anel, armed with a silk thread, is to be introduced. This instrument is to be gradually insinuated along the duct until it appears at the fistulous orifice, bringing with it the thread, which latter drags in its turn a well oiled seton cord attached to its end. The other extremity of the cord is then to be brought out at the mouth, and the two knotted on the cheek as seen at fig. 3. The size of the cord is to be increased from time to time till the duct regains its natural calibre, and the ulcerated orifice begins to contract upon the cord. The end of the seton should then be cut off on a level with the fistulous opening, and drawn a little way within it, where it is to be allowed to remain until cicatrization takes place externally, which is to be aided by occasional touches with the nitrate of silver, and the application of adhesive straps.

3. *Formation of an artificial passage, in case of the obliteration of the anterior or internal part of the canal.*

Method of Deroy.—This consisted in traversing the cheek with a heated wire from the place of the fistula, and is said to have been successful.

Of Duphenix.—A long, straight, and sharp-pointed bistoury was insinuated from the opening downwards and forwards, into the mouth, in the direction of the natural passage. The handle was then rotated between the fingers, so as to render the passage round. The bistoury was next withdrawn, and a short metallic canula of the proper length inserted, terminating by a bevel at its inner end, so as to correspond with the plane of the mucous membrane. The margins of the fistula were then excised, and the wound closed over the outer end of the cylinder, by the twisted suture. The canula, which was left in the wound, came away on the sixteenth day, and the patient was cured.

Monro simplified the method by forming the new passage with a shoemaker's awl of proper size. Tessard and Flajani introduced first a thread by means of a needle, to which was next attached a small silk cord, for the purpose of dilating the previous puncture. In the progress of improvement, these ruder instruments have yielded to one more neat and efficacious. The places of the

awl and the bistoury have been supplied by a delicate trocar and canula. The perforation is to be made from without inwards, as nearly as possible in the direction of the natural passage—a finger covered with a compress being passed inside the cheek to receive the point of the instrument and prevent the tongue from being wounded. The trocar is then to be withdrawn, and a silk cord, a piece of catgut or lead wire, conducted through the canula, which is next to be removed, and the dilating body it had conducted left in its place. If either the catgut or wire be used, the outer end is to be secured so as to prevent its being drawn into the mouth, by a silk thread fastened round the ear or bound down by a piece of adhesive plaster. The inner end of the cord is to be rendered stationary in like manner by a knot, or even tied round a pledget of lint; or if lead wire is used, the end is to be bent down on the lining membrane. As soon as the walls of the new track are sufficiently organized, the external orifice is to be closed, as in the process of Morand. In case the new passage is disposed to contract, a gold canula should be introduced into it, and allowed to remain a long time before closing the fistulous opening.

M. Atti always employed the lead wire, which he secured on the outside in the usual manner with a silk thread, and on the inside by dividing the extremity into three longitudinal slips, which were folded down in different directions on the mucous membrane. When the track was believed to be sufficiently organized, the outer

thread was cut, and the fistulous orifice closed over the lead wire, as in the manner above described.

In all these various processes, no attempt is made to heal the fistulous orifice, till the artificial canal is thoroughly established. In the excellent one next to be detailed, the closure of the orifice is made immediately after the insertion of the new substance, which is to be left in place in order to establish the new channel.

Process of Deguise. (Fig. 3.)—In this, the new passage is made branching so as to open with two orifices on the lining membrane, and in the form of the letter Y. A small trocar is passed from the bottom of the fistula, in the direction of the edge of the masseter, which is not, however, to be wounded, and then carried if possible through the posterior wall of the natural passage into the mouth, where the point is to be received between the two fore fingers of the other hand. The trocar is withdrawn, and the canula left until a fine lead wire is passed through, when it also is removed. The canulated trocar is again introduced from the orifice, and carried downward and forward—at this time in a different direction—which is that of the obliterated duct; a waxed silken or thread ligature is next passed through the canula into the mouth. The canula is then to be withdrawn, as in the case of the first puncture. By fastening together the two outer ends of the wire and ligature, and drawing upon the buccal end of the latter, the wire is passed through the second track of the trocar, so as to present both its extremities in the mouth, em-

PLATE LIII.—SALIVARY FISTULA.

Fig. 1.—*Surgical anatomy of the parotid gland.*—A dissection has been made on the side of the face, in order to expose the relations of the parotid gland and its duct, as well as that of the submaxillary gland, with the surrounding parts.

1. Superior extremity of the sterno-cleido-mastoid muscle.
- 2, 3, 4. Masseter, zygomaticus major and buccinator muscles.
- 5, 6. Facial artery and vein.
7. Branches of the facial or portio dura nerve, which run parallel with the parotid duct.
 - a. Parotid gland.
 - b. Parotid duct, or duct of Steno. The reference (b) is placed on the duct at the point, at which the salivary fistula is most frequently found to occur.
 - c. Submaxillary gland.
 - d. Commencement of the duct of this gland, or duct of Wharton.

Fig. 2.—*Dilatation by the seton.* (*Process of Morand.*)—With the probe of Anel a seton composed of several silk threads has been passed from the fistulous orifice, and brought by the buccal orifice of the duct out through the mouth. The two extremities of the seton have then been knotted upon the cheek.

Figs. 3, 4.—*Puncture for the purpose of making a new passage.* (*Process of M. Deguise.*)—A first puncture has been made from before backwards, bringing out one end of a cord upon the cheek, and leaving the other end in the mouth. At the period of the operation shown, a second puncture in the direction of the duct is made from behind forwards, with the canulated trocar of M. Grosserio. A small pledget upon the fore finger of the surgeon, serves to receive the point of the trocar and protect the tongue from injury. The outer end of the cord is then to be passed through the canula after the stilet is removed, and the canula with the cord brought out through the orifice of the mouth.

Fig. 4.—The two ends of the cord are then to be knotted in the cavity of the mouth. The loop of the cord or ligature rests at the bottom of the fistulous orifice of the canal, the outer opening of which is now to be made to cicatrize.

Fig. 5.—*Same process,* executed with two needles introduced from the fistulous orifice, each of which has a separate direction, and is carried through into the cavity of the mouth, bringing with it one of the ends of the cord.

Fig. 6.—*Horizontal section of the cheek,* showing the circular loop formed by the cord in the inner substance of the cheek, and the fistulous passage from the duct opening externally, through which the needles and the ends of the cord have been introduced.

Fig 2



Fig 4

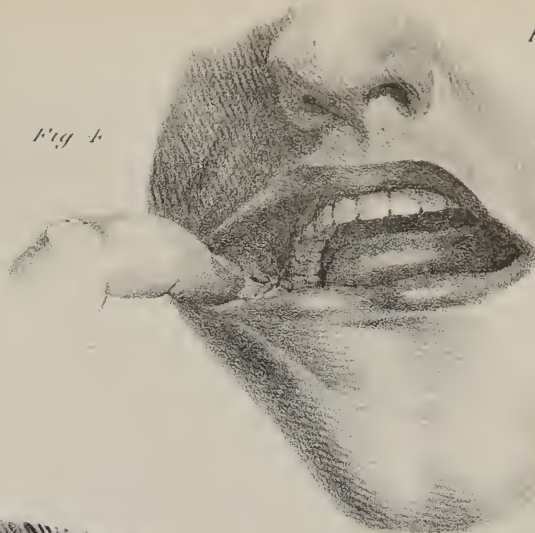


Fig 1

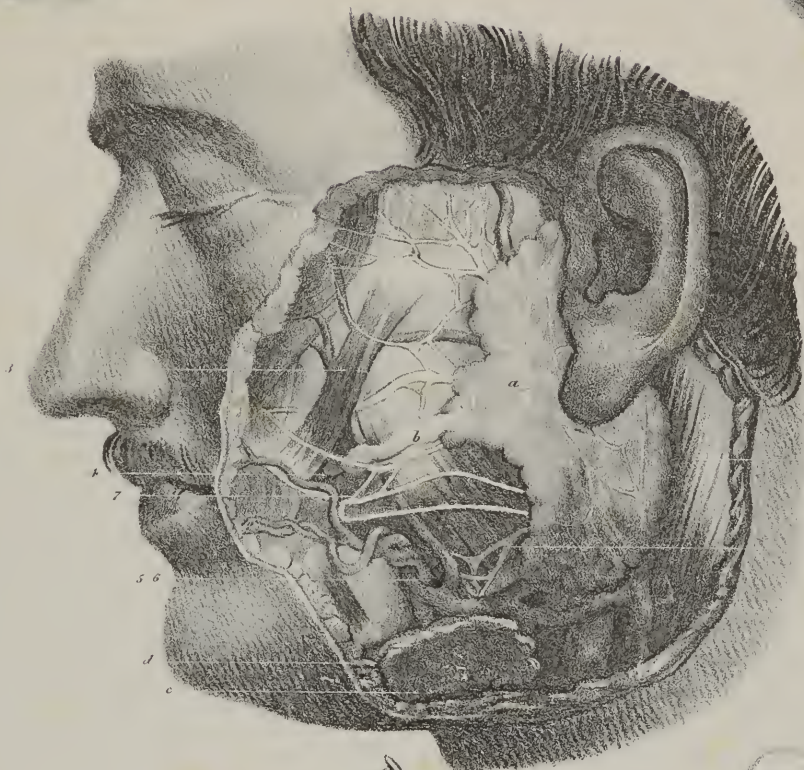


Fig 5

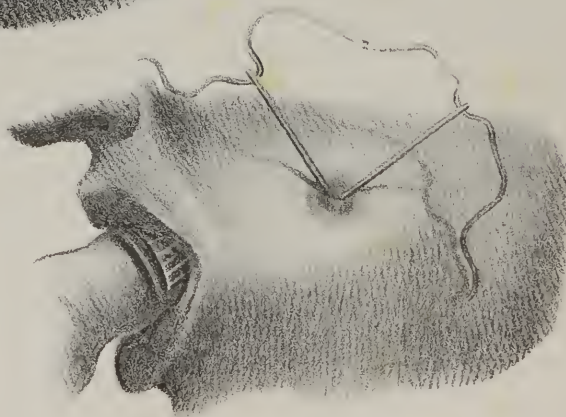


Fig 3



Fig 6



bracing the substance included between the two branching passages in its loop, the middle part of the loop resting in the bottom of the fistula. The ends of the wire are then linked together in the mouth, shortened and laid down flat upon the membrane, and the external fistula closed at once, by the excision of its edges and the application of the twisted suture. After this has united completely, the wire may be removed, or, if preferred, left till it divides in the manner of a ligature the little fleshy bridge within its loop.

A stout silk cord may, however, be employed instead of the wire, and will be found more manageable. M. Vernhes made use of a gold wire, and suggests—which is a matter of importance—that the trocar should in both instances be directed from above downwards, but in different tracts, so as to avoid more surely the edge of the masseter, and the facial vein which runs by its side.

Another useful modification has been suggested by M. Gros-serio, viz., to substitute for the ordinary small hydrocele trocar employed by Deguise, one from which the button of the canula unscrews, so as to permit of its being drawn out through the mouth, carrying with it at once the end of the wire or ligature, which is to be left in the track. Malgaigne has proposed to carry simply the ends of a silk ligature from the bottom of the fistula through into the cheek, by means of a couple of ordinary needles. The ends are to be knotted on the mucous membrane, as seen at Pl. LIII. fig. 4. The fistula is to be closed, and the treatment in other respects conducted as in the process of Deguise.

Process of Bonnafons.—In a case* of fistula of the duct, occasioned by abscess, which had resisted several attempts to cure it by operation, M. Bonnafons succeeded by means of the following method. Having laid bare the ulcerated extremity of the duct with a knife, he passed a slender cutting blade into the mouth in the direction of the obliterated duct, and introduced a canula along the track. A ligature passed through one side of the free end of the duct, was then carried through the canula, and fastened to its buccal end in order to keep the canula in its place. The external wound was closed in the ordinary manner, and the cure was completed on the fifteenth day.

4. Obliteration of the natural duct for the purpose of suppressing the salivary secretion by producing atrophy of the parotid gland.

This may be attempted as a last resource when the fistula is formed on the outer surface of the masseter, near its origin from the gland, and when the means of cure above advised have proved unavailing. It may be accomplished either by steady compression of the duct on the parotid side of the fistula, or by cutting down upon it at the same point, isolating it from the branches of nerves, and tying it as we would an artery. The latter measure would be the most rational and effectual, and least likely to produce an inflammatory engorgement of the gland. Neither, however, has as yet been tried upon the human subject. But the ligature has proved successful in experimental trials upon the horse, without any inconvenience arising from the altered physiological condition of the gland.

When the attempt is made to close the external orifice by suture, the jaws should be kept closed and the patient forbear to

speak until union is effected, taking only liquid aliments, so as to avoid any discharge of the saliva which would interrupt the healing process.

Fistulae of the parotid gland.

These are of two descriptions, according as they involve one or more of the smaller ducts on the back part of the parotid, or the larger branches of the duct of Steno as they emerge from the gland. The former are easily cicatrized by cauterization with the nitrate of silver, or the repeated application of small blisters as advised by Velpeau. If the latter prove intractable to these measures, a trial may be made of the gold leaf, made adherent by pitch, as advised by Malgaigne;—or the ulcer may be extirpated by embracing it between two elliptical incisions, as proposed by Velpeau, and closing the lips of the wound left, with the twisted suture or adhesive straps.

EXTIRPATION OF THE PAROTID GLAND.

Surgical anatomy of the gland.—The surgical region of the parotid is bounded—anteriorly, by the posterior border of the ramus of the lower jaw, and the internal pterygoid muscle;—posteriorly and inferiorly, by a sloping wall, formed by the mastoid process of the temporal bone, the anterior border of the sterno-cleido-mastoid, and the posterior part of the digastric, stylohyoid and stylo-glossus muscles. The space thus bounded in front, behind and below, is of a pyramidal or prismatic shape, with its base presenting externally to the skin, and its apex to the styloid process and the outer wall of the pharynx. The posterior and inferior wall forms a sloping plane up to this point. The pterygoid muscle, which chiefly forms the anterior wall, slopes backward and inward, but is directed a little above and in front of the base of the styloid process, to reach the pterygoid fossa. Thus, at the apex of this prismatic space, there is left a sort of fissure between its walls, filled either with fat or a process of the gland on the side of the pharynx, just behind the attachment of the velum palati. The sheaths of the muscles forming these walls are continuous with one another, and form a cellular lining for the cavity, which is connected with the stylo-maxillary ligament and the internal lateral ligament of the articulation of the jaw. The gland is lodged in this space, which it fills up completely, and moreover in the healthy state sends processes which extend beyond it. The whole mass of the gland may, for the sake of description, be considered as divided into two portions—one superficial, which, extending beyond the limits described, overlaps the edge of the masseter muscle, extends below the angle of the jaw, and embraces the upper, anterior and lower surfaces of the external auditory meatus—and one deep-seated, continued inward from the former, which not only fills up the triangular space above described, but surrounds the neck of the condyle and the articulation of the jaw, and dips under the internal edge of the internal pterygoid muscle. The gland is surrounded by a fibrous capsule, which sends processes between its lobes, so as to penetrate it in all directions, fix it firmly in the excavation, and render it adherent posteriorly to the sheath of the sterno-cleido-mastoid muscle.

The external carotid artery passes up in a curve, concave forwards, through the inner portion of the substance of the gland,

* Annales de Chirurgie Française et étrangère, 1841.

surrounded ordinarily by a small portion of its structure, and divides at the head of the condyle into two branches, the temporal and internal maxillary, both of which are more or less embraced at their roots by the substance of the gland. The posterior auris is given off usually from the carotid as it traverses the gland. The transverse facial artery usually runs on the posterior face of the gland between it and the masseter, and the occipital is merely in contact at the place of its origin with the posterior surface. The veins of the part follow the course of the arteries. The internal carotid artery and the internal jugular vein, though not included in the parotid region, are placed, it should be recollected by the operator, so near its inner boundaries as to be in danger of injury if a cutting instrument is carried even to a little extent beyond the inner limit of the space above described.

The facial nerve divides into a plexus in the substance of the gland, and traverses it from behind forwards and from above downwards, exterior to the external carotid artery and external jugular vein, leaving about one-third of the substance of the gland on its posterior face. The superficial temporal nerve traverses the front of the gland just behind the condyle of the lower jaw. The more important nerves of the neck, the pneumogastric, glosso-pharyngeal, hypoglossal, spinal, and chorda tympani nerves, are not included in the parotid region, though they are placed but at a little distance from its inner surface, covered by the posterior belly of the digastric muscle and the internal jugular vein. The lymphatic glands of this region vary in number in different individuals; from two to six or seven are usually found on the surface of the gland partly imbedded in its interlobular spaces. One or two deep-seated lymphatic glands are usually found by the side of the external carotid artery and external jugular vein.

It would seem from this brief sketch of the anatomy of this region, that the parotid gland was too deep seated and sent off too many irregular prolongations wrapped round the parts at its inner surface, to admit of its thorough extirpation. This is unquestionably the case in reference to the gland in its healthy state—and if it was alike true in its scirrhus condition, the attempt at its extirpation would be a useless operation, inasmuch as some of the degenerated portion necessarily left would serve to reproduce the disease. But, as has been observed in the first instance I believe by Dr. Jacob Randolph of this city, the scirrhus affection of the gland is attended by a contraction of its capsular investment, by which the deep-seated and irregular prolongations are made to recede from their beds, so as greatly to facilitate the process of extraction.

Though the operation was considered impracticable by Boyer and the greater part of the older surgeons, there is no question that it has been many times completely removed, both by the surgeons of this country, of whom may be enumerated in reference to this operation, Drs. McClellan, Warren, Mott, Randolph, Smith, and by many of those of Europe. About forty cases of its extraction have been enumerated by Velpeau, twenty to twenty-five of which are stated as having been successful; but that the complete extirpation of the gland has in this number of instances been effected, has been seriously questioned by M. A.

Berard,* in a careful examination of the reports of the operations. There is every reason to believe that in many of the alleged cases of successful extirpation of this gland, there has not been a true scirrhus degeneration of its structure, but a mere *tumour* of the parotid region formed by the enlargement of the common lymphatic glands of the part, which, as they increased in size and encountered resistance from the skin and superficial fascia, pressed inwards so as to cause the gradual removal by absorption of the true parotid gland, and bring themselves in the end so as to occupy the same position. When it is merely this morbid development of the superficial glands that causes this change in the parts, the *parotid tumour*, to whatever depth it may reach, presses in before it both the portio dura nerve and the external carotid artery, thus rendering its extraction easy and not necessarily involving any important parts. The instances of alleged extraction of the scirrhus parotid, of which there are many on record, unattended by hemorrhage or the necessity of tying any important arteries, or the division of the portio dura nerve and consequent palsy of the face, have, it is most probable, been cases merely of this description.

Operation.—Some surgeons have deemed it proper to tie the external carotid artery at the commencement of the operation, by a previous incision in the neck; others to expose the carotid and throw a ligature loosely round it, which could be knotted if at any moment such a proceeding should be rendered necessary by the effusion of blood during the removal of the tumour. It is more generally advised, however, to proceed to the operation without any previous ligature of the vessel, tying it as the trunk becomes obvious during the extraction of the tumour, or securing the bleeding orifices as they are opened with the knife, obviating the possibility of profuse hemorrhage by adopting the precaution of Dr. Warren, to have an assistant ready, in case of accident, to make compression on the trunk of the primitive carotid in the neck, until the surgeon can secure the wounded vessel.

The patient should be laid on an inclined plane with his head turned to the sound side and well supported by assistants. The form of the external incision must depend upon the size and shape of the tumour. That of a Γ or a crucial incision has been most generally preferred. The cutaneous flaps are to be reverted from over the tumour, and the ear with its lobule drawn strongly upwards and backwards by an assistant, so that the concha may not be cut in the subsequent steps of the operation. The surgeon now grasps the tumour with his left hand if it be large, or with a pair of hook forceps if small, and draws it off from the side at which he is at the time detaching the tumour. It answers best to pursue the process of detachment with the knife, first at the superior border of the gland, then at the posterior border where its limits are most definite, taking care to avoid cutting into the meatus, or into the ligaments of the temporo-maxillary articulation, keeping close to the anterior edge of the mastoid process, so as to leave the external carotid to the inner side of the track of the knife. When the gland is in part separated at these points, the detachment of the cellular connections of the tumour may be con-

* *Maladies de la Glante Parotide, etc.*, par M. A. Berard: Paris, 1841. This author has collected fifty-two cases of operations for tumours of the parotid; in only five of which does he think it certain that the gland has been removed entire.

tinued with the handle of the scalpel instead of the blade, which will diminish the risk of injuring the important vessels or nerves. In loosening the gland in this way from the fossa behind the ramus of the jaw, additional precaution must be observed not to injure the trunk of the external carotid or either of the branches into which it subdivides. The smaller arteries of the part—branches of the auricular and the occipital—must be tied as they are cut. The surgeon proceeds now cautiously, using partly the point and partly the handle of the scalpel, and feeling from time to time with the finger for the pulsation of the external carotid, so as to expose this vessel, which is found enveloped in a portion of the diseased gland. A needle with a double ligature should be carried below the artery, which is to be tied at two points a few lines apart, and divided between them. The anterior margin of the gland may then be detached from over the masseter muscle as far as the ramus of the jaw, though this, if the surgeon prefers it, may be made as the initiatory step of the isolation.) The tumour now holds only by its middle and deep-seated parts, and its dissection must be continued from below upwards. At the inferior angle of the wound we encounter the external jugular vein, which is often of considerable size. When it is necessary, as is sometimes the case, to cut this vein, it should be previously compressed below the place of division, in order to prevent the entry of air into the circulation. As the operator proceeds upwards in the detachment of the gland, he is to guard against cutting the submaxillary gland or the facial artery, which lie at its anterior and inferior part. Having once loosened it so as to raise its lower end, the final separation of the tumour is to be effected as far as possible with the handle of the scalpel, which will best enable the operator to isolate the morbid from the healthy parts, and even to detach the prolongations of the gland without risk of injuring the neighbouring vessels. If the tumour is firm and encysted, it may be wholly detached in this way with the handle of the knife. But if it be not encysted, and the prolongations are too hard and resisting to be loosened with the handle, they must be separated with the point, observing the precaution, however, to *keep the edge of the blade turned to the side of the tumour* rather than towards the surrounding parts, which might otherwise be cut. In this way we run a risk of leaving at the moment a portion of the degenerated structure; but this may be subsequently removed after the detachment of the mass of the gland and the suppression of the hemorrhage. If the external carotid should be cut before it was exposed and tied, the assistant should instantly compress the primitive trunk in the neck, and the surgeon grasp the bleeding vessel just below its orifice with the forceps in one hand, whilst with the other he passes a needle with a double ligature below it, for the purpose of tying the vessel. The trunk of the facial nerve will in most cases have to be divided; this will be found running in the direction of a line from the anterior groove of the mastoid process to the angle of the jaw.

When the gland is almost entirely detached, it may be found holding by one of its prolongations which forms a sort of pedicle at the bottom of the fossa, dipping into one of its recesses. This has been found to contain vessels which, when divided across, occasion a hemorrhage that it has been found very troublesome to arrest. It will therefore be found better, as recommended by M. Begin, to tie it and divide it on the outer side of the ligature.

After the removal of the tumour, it will be proper to examine carefully whether any portions of the degenerated gland have been left. If such should be found, they are to be detached with a spatula, the handle of a scalpel, the point of a director, or the finger nail, and if soft, as they are commonly found under such circumstances, may, with care to avoid the injury of the internal jugular vein and other important parts, usually be removed. Such arteries as have been divided are to be carefully tied. If the gland has been detached from below upward, and the external carotid tied at the bottom of the wound, the number of vessels requiring ligature will not be great. The capillary oozing, and that from the divided veins, is to be arrested by pressure with the lint or charpie used in the dressing, which may if necessary be applied so as to fill up the wound. The actual cautery, which has been sometimes resorted to to arrest bleeding, can rarely be required, and should, if used at all, be employed with extreme caution, for fear of injuring the internal carotid, the important veins of the part, or the bones at the base of the brain. When the hemorrhage is completely arrested, the flaps, if the wound left be not deep, should be brought together with the hare-lip suture, leaving, however, an opening for the exit of the fluids at the bottom of the wound. But if the cavity left is deep, or the skin has been involved in the disease, so as to necessitate the removal of a portion of it along with the tumour, the wound must be dressed from the bottom, and allowed to close by granulation. The difficulty of swallowing in consequence of the injury or division of the styloid muscles, the risk of secondary hemorrhage, and neuralgia of the teeth and face, are among the circumstances that will require the attention of the surgeon during the cicatrization of the wound.

Such, in ordinary cases of scirrhus parotid, will be found the best process for its complete extirpation. The rules cannot, however, be positively traced for all cases; each individual one will be found to present some peculiarity in the course of the process, which the surgeon, who is master of the general plan of operation, will be able to meet.

Removal by the ligature.—M. Mayor has proposed, after laying bare the gland, and reflecting the cutaneous flap, to pass ligatures through it in different directions, and strangulate it in separate portions. The proposition of this surgeon has not, however, been received with favour. The location of the gland is such, that it would be utterly impossible to strangulate it in all its parts.

EXTIRPATION OF THE SUBMAXILLARY GLAND.

The removal of this gland, which is but seldom required, may be readily effected. An incision should be made of a length proportioned to the size of the enlarged gland, along the base of the jaw, commencing at the angle. A vertical incision is to be dropped from the posterior extremity of this, and the skin and platysma muscle dissected up in a triangular flap and reverted forwards and downwards. The gland, with the lymphatic ganglions which surround it, is now exposed to view; it is to be raised with a pair of hooked forceps, and partly by dissection and partly by tearing enucleated from its bed. The facial artery, if too much involved in the tumour to be readily separated from it, is to be tied and cut. The wound may be closed at once in order to bring about union by first intention.

RANULA.

This is a tumour, of the colour of the surrounding parts in its early stage, situated under the side of the tongue, and between it and the floor of the mouth; usually soft, fluctuating and transparent, but sometimes hard and firm. The tumour may be single, or there may be two, one upon either side of the tongue. If of small size, it causes but little inconvenience, but if forming a larger bulk, it presents a serious obstacle to mastication and speech. In some instances, it has been found so large as to drive the incisor teeth outward, and protrude the parts below the chin. The nature of the affection is not as yet fully understood. Many of the older surgeons, Camper, Louis, Desault, Chopart, Richter, and Boyer, were of opinion that it originated from an obstruction of the excretory duct of the sub-maxillary gland,—the ductus Whartonianus,—and the consequent accumulation of saliva; but this opinion has not been supported by accurate anatomical examination, and the chemical analysis of the contents of the tumour. That such an obstruction occasionally does occur, and gives rise to calcareous deposits, is beyond doubt; but, according to Dupuytren, it has nothing in common with ranula, except an apparent similarity of seat. The fluid of ranula is oily, brownish, viscid and albuminous, and is deficient in the principal constituents of the saliva. I have found the Whartonian duct permeable in many cases of ranula, and in the instances in which it has been closed, this result has appeared, according to Reissinger, more as a consequence of the pressure of the tumour upon it, than as the primitive cause of the disease. It is very probable that ranula, in many instances, at least, is little more than a cystic tumour, developed in the substance of the salivary lobules, or by the side of their excretory duct. More accurate observation, however, is required to settle its pathology. The modes of treatment in this affection are nearly as discordant as the pathological opinions entertained respecting it. Paré opened the tumour with the actual cautery, applied through a hole in an iron plate. Heister opened it largely with the lancet and to prevent a new accumulation of the fluid, washed it out daily with mel rosatum and sulphuric acid. The incision, however, has to be large, or the cyst fills again quickly, and is never alone to be relied on for a radical cure. Van der Haan drew a seton through it to produce suppuration, and Callisen opened the cavity and stuffed it with lint. When the tumour was very large, and protruded the parts below the chin, Sabatier opened it by a puncture with a trocar, from below upwards through the skin, and kept the orifice open with a mesh. Acrel merely opened the tumour, and applied muriatic acid to the surface of the cavity. Camper and Vogel opened the tumour, extirpated a part of its walls, and touched the remainder of its inner surface with caustic. Louis excised an oval portion of its walls, and touched the orifice with lunar caustic to prevent its closing. Chopart and Desault endeavoured to keep the salivary duct open by the introduction of a fine lead or silver wire; failing to cure by these means, they punctured the tumour and introduced through the orifice a thick lead wire, which was taken out from time to time to discharge the fluid that had collected. Dupuytren, instead of the wire, inserted through the puncture made with the lancet, a silver, gold or platina cylinder, with a small elliptical button at each end to keep it permanently in place, by the side of which the fluid, as it formed, was discharged.

This instrument, when once inserted, was not afterwards to be removed. Græfe found these various measures frequently insufficient for a cure; he objected to its total extirpation, as proposed by Marchetti, particularly if the tumour was large, on account of its causing excessive hemorrhage and inflammation, and recommended the following process, (that of Petit,) which I have several times practised with success when the walls of the cyst were thick and resisting. The mouth is to be opened wide, and a sharp hook deeply inserted into the most prominent part of the tumour, so as to raise its anterior wall, which is then to be excised along with the mucous membrane that covers it, with a small pair of scissors. The removal of a small piece will be found insufficient—at least the half of the tumour should be taken away. The operation should be performed quickly, and before the contained fluid is allowed altogether to escape, for the tumour collapses after the discharge of the fluid, and it is difficult then to define its extent. The bleeding after this operation is generally but trifling. The remaining portion of the cyst, according to Græfe, should be daily touched twice with muriatic acid. This may in some cases be necessary, but in general the obliteration of the cyst will be complete without the use of any irritant or caustic application after the excision of a large part of the wall. Kyll excised the prominent part of the tumour in the manner of Græfe, and in addition, when it was found firm and hard, depressed the bottom of the cyst with a grooved director, until he could feel the end of the instrument below the chin, and from this point introduced a seton needle upwards and outwards through the cavity of the cyst, allowing the cord to remain, which was moved from time to time so as to excite the suppuration and ultimate obliteration of the cavity. If not found sufficiently exciting without, some irritating ointment was smeared upon the seton. Richter recommended in children simply the touching of the whole periphery of the tumour with caustic, repeating the process until a cure was effected, which, according to him, never required more than ten applications.

Of the various processes above mentioned, those of Louis and Græfe appear the most appropriate—the former in the soft, ordinary ranular tumour, the latter where the walls are thick and resisting. The author, however, has latterly been induced to give a decided preference over that of Louis to the following operation for the cure of this affection. He passes vertically through the anterior portion of the walls of the cyst, a sharp tenaculum, which is to penetrate at first into the bottom of the cavity, and pierce the wall a second time above. A broad curved needle, cutting on the edge, is then passed horizontally across the cyst, entering upon one side and emerging upon the other side of the tenaculum, so as to lodge a stout ligature completely in the cavity of the sac, and include, according to the size of the tumour, half an inch to an inch of the wall between the places of puncture. The tenaculum is then to be removed and the ligature firmly knotted upon the wall of the cyst, and the tails cut off, leaving the knot till it is discharged by ulceration. The gaping of the puncture made by the closing of the knot gives space for the discharge of the fluid, and the ulceration, which is necessary to loosen the thread, keeps the orifice effectually from closing. By the time the knot is thrown off, all semblance of the cyst usually disappears.

Cysts of a somewhat analogous description to that of ranula, filled with a colourless albuminous fluid, are occasionally met with in other portions of the wall of the mouth—as, for instance, in the substance of the lips and cheeks, between the gums and the cheek, and between the gums and the tongue. Excision of a portion of these walls, with cauterization of the remaining part, or complete extirpation, are the common means resorted to for their cure.

OF THE TONGUE.

ANKYLO-GLOSSUM, OR ADHESION OF THE TONGUE.—TONGUE-TIE.

Tongue-tie.—It will suffice to notice this subject briefly. It is commonly a congenital defect caused by the frenum being too short, or extending too near to the tip of the tongue. It embarrasses the child in sucking, and may afterwards prove an impediment to speech. The defect is easily remedied. The tongue is to be raised by two fingers, passed, one on either side of the frenum, which is to be snipped with a pair of blunt-pointed scissors in a downward direction, to avoid wounding the raninal or other vessels of the tongue. A split spatula may, if preferred, be used in place of the fingers to raise the tongue and expose the frenum. Some surgeons direct only the outer margin of the frenum to be cut, and leave the fold to become stretched afterwards by the motions of the tongue. The operation is often unnecessarily performed, it being by no means of such frequent occurrence as mothers and nurses fancy. In case bleeding of any consequence should follow, a white-hot knitting needle may be applied to the mouth of the divided vessel, or a small compress—which is to be supported by a forked stick as directed by Dr. Physick, one end of the stick resting upon the incisor teeth, and the branches of the other upon the compress; the mouth of the child should be maintained open for a time by some substance between the gums, to prevent its keeping up the hemorrhage by suction. If the least suspicion exist of any occult bleeding from suction, the child should always be applied to the nipple immediately as it awakes. If the tongue is rendered adherent, as is sometimes the case, by lateral bridles, they are to be divided in a similar way with the scissors or the knife.

General adhesion of the tongue.—The whole under surface of the tongue is sometimes found adherent to the bottom of the mouth. This occurs occasionally as a congenital defect, but more frequently as the consequence of burns or ulceration. Nothing here is to be done but to loosen the tongue with the knife in the following manner, as cautiously as possible, and as far inwards as necessary. The mouth should be held open by placing pieces of cork between the teeth; an assistant should sustain the head of the patient, and at the same time lift up the tip of the tongue with the fingers, so as to stretch the parts slightly. The operator then loosens the adhesion of the point and sides of the tongue from the bottom of the mouth with a convex bistoury, beginning at the sides and avoiding as much as possible the larger vessels. Those which bleed profusely have either to be tied or treated with styptics or the cautery. If the operation be performed on an infant, it might happen, if loosened to any considerable and unnecessary

extent, that the tongue in sucking would become inverted upon the glottis so as to produce suffocation. To prevent this, it would then be necessary to put a thick compress upon the tongue, and secure it with a tape around the chin.

STAMMERING.

The following operations have been, within a few years past, practised for the cure of stammering; but as they were rarely found attended with permanent benefit, and in some instances proved to be so serious as to involve life, they have been, with the exception below mentioned, entirely abandoned. Brief mention is made of them here merely as matter of history.

1. Simple transverse division of the muscular structure of the base of the tongue, either by direct or subcutaneous incision. (*Dieffenbach.*)
2. Transverse division with excision of a wedge-shaped portion from the base of the tongue. (*Dieffenbach.*)
3. Excision of a triangular piece of the bodies of the genio-hyo-glossi muscles. (*Mr. Lucas.*)
4. A simple incision in the bodies of the genio-hyo-glossi muscles. (*Amussat, Philips, and Velpeau.*)
5. Division of the attachment of the tendons of the genio-hyo-glossi, and sometimes also of the hyo-glossi muscles. (*Bonnet and Baudens.*)
6. Simple division of the mucous and subjacent tissue of the floor of the mouth, said to have been found sufficient. (*Amussat.*)
7. Excision of a portion of the apex of the tongue. (*Velpeau.*)
8. The excision of the uvula and tonsils. (*Mr. Yearsley.*)

In nearly all cases the immediate cause of stammering will be found in the irregular and convulsive action of the muscles of phonation, remediable not by any process of operation, but by well-directed and long-continued exercise in the practice of elocution. Instances, however, now and then occur in which, from a permanent shortening or unyielding contraction of the genio-hyo-glossus muscles, the front portion of the tongue is held so low that the point cannot with ease be applied to the roof of the mouth, and has a constant tendency to protrude between the teeth. In such instances there is a muscular tie of the tongue, and the division of the tendons of the genio-hyo-glossus muscles may be made with advantage. Three cases of this description have come under my notice, in which the defect was traceable to a previous cerebral affection. In two I practised the following operation, with the effect of improving in one of them very considerably his powers of speech.

Section of the genio-hyo-glossus muscles.—The patient is to be seated with the head thrown back. The operator, seated in front, places the left fore finger in the mouth below the tongue, with the end resting against the tubercles on the inner face of the chin, with which the tendons of these muscles are connected. A puncture is then to be made opposite to this point through the integuments and platysma muscle below the chin, and in the interval between the digastric and mylo-hyoid muscles. A blunt pointed tenotomy knife is then carried up through the puncture with its edge forward, so as to separate the tendons of the genio-hyo-glossi of the two sides, and until it can be felt by the finger directly below the mucous membrane. The blunt point of the instrument

should be made to project even between the folds of the frenum, so as to insure the division of the upper fibres of the muscles, which it is most important to cut. The edge of the knife is now turned obliquely outwards, first to the left, and then to the right, so as to cut in succession the tendons of the two muscles with the handle depressed close to the skin of the neck, in order to keep the edge in contact with the inner surface of the maxillary bone. The division of the muscles is made known by a slight snap, accompanied with a yielding of the part. The extent of the lateral section either way should be to the outer edge of the external incisor tooth, and great care should be observed not to cut through the mucous membrane into the cavity of the mouth, as this would give a ready outlet to the blood, and aid in keeping up the bleeding. The knife should be kept with its edge close to the bone, for fear of wounding a small arterial branch that crosses just behind the jaw. If the division of the muscle has been complete, the patient will have lost to a great degree the power of protruding the tongue. The blood accumulated below the mucous membrane is removed by absorption in the course of a few days.

OPERATIONS ON THE TONGUE.

Carcinoma and other malignant affections of the tongue, chronic hypertrophy, fungous and erectile tumours of the organ, are the causes which in some instances require the removal of a part, or in extreme cases even the whole of the organ. Some of these affections are dependent on a general derangement of the alimentary organs, or form a part of a disease which has involved the

regions of the neck and throat, and will require to be managed by a well-regulated system of internal treatment. In such as are merely local affections, the removal of portions of the tongue either by excision or ligature may be resorted to, especially if they occasion great inconvenience, or are likely to endanger life. When the apex of the tongue is the seat of the affection, its removal by incision has in general been preferred to the ligature, as the bleeding to which it gives rise is but of little moment and easily controlled. Bégin even recommends the use of cutting instruments in all cases, as the ligature is frequently followed by extensive sloughing and suppuration, and the swallowing of offensive fluids endangering life.

Removal with cutting instruments.

1. *By incision.*—Small pediculated and encysted tumours, and horny excrescences of various sizes, sometimes occur upon the surface of the tongue, which may be removed at once with the bistoury or scissors. It will be well afterwards to touch the surface with caustic, for fear of a re-development of the disease. If tumours of the encysted kind are imbedded, as is sometimes the case, in the substance of the tongue, they must be loosened and turned out by dissecting them off from their cellular attachments, partly with the point and partly with the handle of the knife.

2. *By excision.*—This may be practised either with the bistoury or a pair of strong scissors, according to the nature of the case.

With the bistoury.—For an operation of any moment on the tongue, the patient should be placed on a chair with his head

PLATE LIV.—OPERATION FOR CANCER OF THE TONGUE.

Fig. 1.—*Removal of one half the tongue with the scissors.* (*Process of Boyer.*)—The healthy border of the tongue is drawn outwards with the left hand of the surgeon (*c*), and the diseased portion with the hook (*d*). A longitudinal incision has been made down the middle of the tongue, and at the period of the operation shown, a pair of strong scissors (*f*) are seen applied for the purpose of making a second incision, so as to detach the whole of the diseased mass in a triangular piece.

Fig. 2.—*Removal of the anterior part of the tongue with the bistoury.*—The tongue is drawn out with a pair of hook forceps (*forceps of Museux*) (*g*) applied to the point, which is the seat of cancer. An assistant grasps with his thumb and fore finger, one of the margins of the tongue. The surgeon with the bistoury (*h*) has completed one of the branches of the Λ incision from before backwards, and is seen completing the second by bringing out the instrument from behind forwards so as to detach the piece. In this operation the scissors might be made to serve in place of the bistoury.

Fig. 3.—*Closure of the wound after the preceding operation, by means of an interrupted suture behind, and a twisted or hare-lip suture in front.*

Figs. 4, 5.—*Removal by ligature.*—In *fig. 4* is shown the introduction of the needle according to the proposition of M. Maingault through the cavity of the mouth, from the base of the tongue towards its dorsal surface, so as to avoid any external wound, as in the processes more commonly employed. The head is thrown well backwards, and the surgeon stands behind the patient. The first ligature, which is intended to be carried out over the tip of the tongue, has already been inserted. A curved needle has been insinuated under the base of the tongue, and brought out at the orifice made by the first puncture on the dorsum, so as to apply the second ligature, which is to strangulate the side of the tongue.

In *fig. 5*, both the longitudinal and lateral ligatures are shown tightened with the *serre-nœud* of Roderic as modified by M. Mayor, which consists of a series of small pierced balls strung on the two ends of each ligature, and tightened by a sort of tourniquet at the end. Between the two the diseased portion of the tongue is circumscribed, so that we may at will, according to the force of constriction applied, effect the complete sphacelus, or the mere atrophy of the organ as has been proposed by M M. Mirault and Maingault.

Fig. 4



Fig. 1

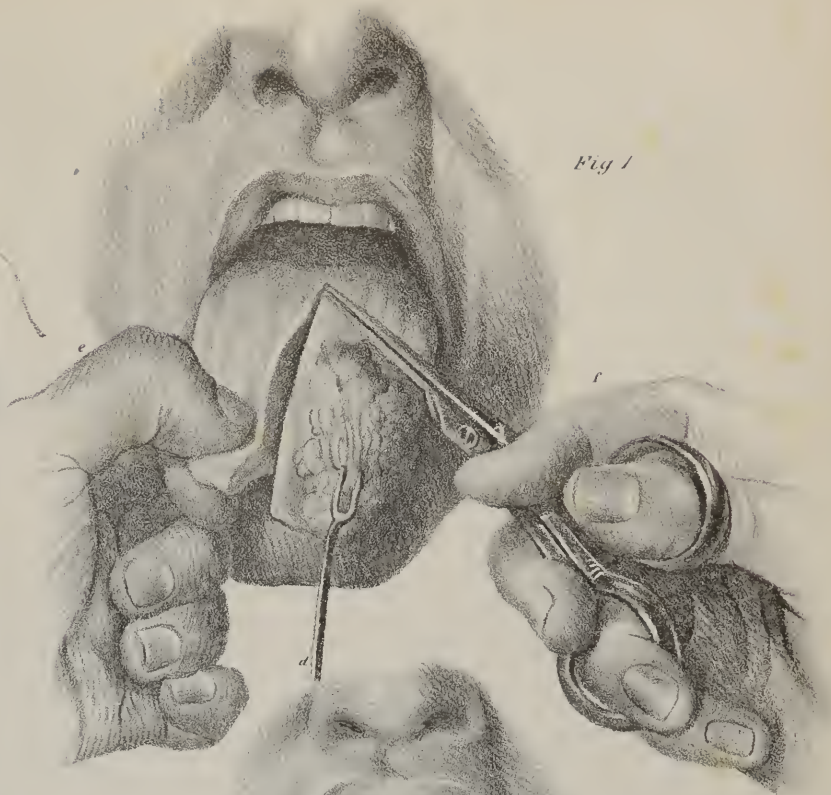


Fig. 2

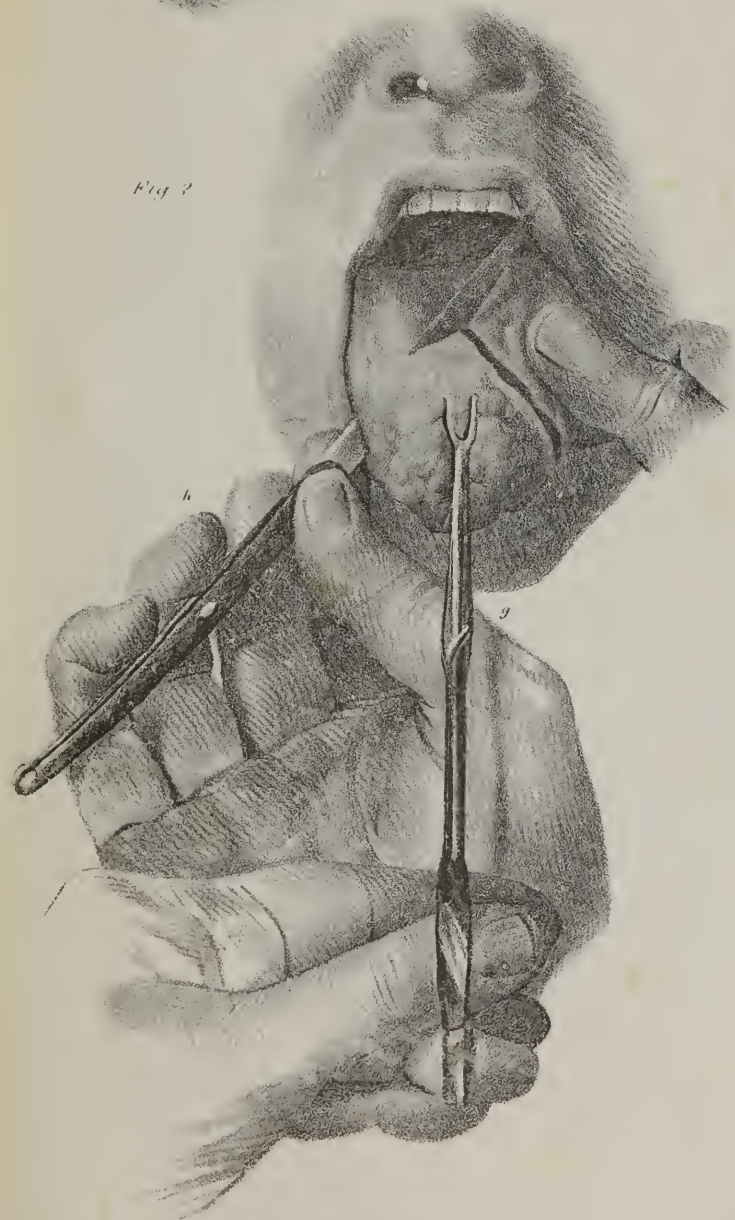


Fig. 5

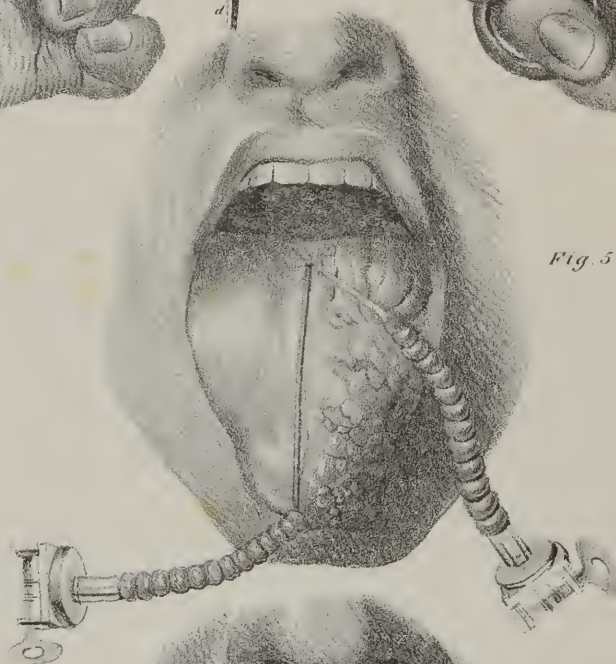
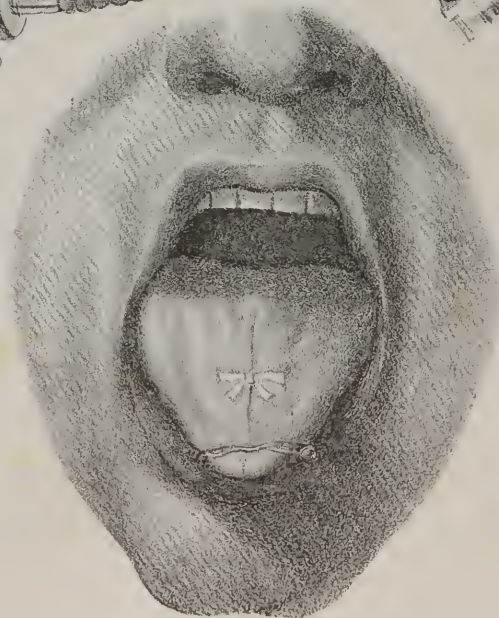


Fig. 3



supported against the chest of an assistant, and his mouth kept well open with a cork, compress, or the blades of a speculum between the teeth of the sound side. When there is a superficial linear degenerated ulcer of the free surface, or of one of the borders of the tongue, two elliptical incisions may be made with the bistoury through the healthy structure, so as to detach all the diseased portion, which should be seized and raised up for the purpose with a pair of hooked forceps. If there is a cancerous affection of the point, or of one of the margins of the tongue, extending a little way into its substance, the tongue should be drawn out from the mouth with the fingers or a pair of hook forceps, and the tumour detached in a Λ shaped piece, by two incisions, as shown in fig. 2, leaving a wound readily united as seen in fig. 3.

With the scissors. (*Process of Boyer*, Pl. LIV. fig. 1.)—The sound side of the tongue is to be seized with the thumb and fore finger of the left hand, so as to allow of the use of the scissors in the right. The first incision should be made in the longitudinal direction of the tongue, beyond the extent of the disease, and, if possible, by a single stroke with the scissors. The patient is now to be allowed to clear his mouth of the blood. The surgeon lays hold of the diseased portion with a hook, and has it made tense by an assistant, while he makes a lateral cut with the scissors, joining the longitudinal at an acute angle, so as to completely circumscribe a triangular portion of the tongue, including all the diseased mass. A sort of Λ shaped wound will be left. The mouth is to be well rinsed out with iced alum water, and the lips of the fissure brought closely together, with the interrupted suture, which will suffice to arrest the hemorrhage. The cicatrization of this vascular structure may be expected to be complete between the sixth and the tenth day.

In a case of cancerous ulcer affecting one margin of the *posterior part of the tongue, and the anterior half arch of the fauces*, Lisfranc effected excision in the following manner: he had the tongue drawn strongly outwards by an assistant, then grasping the diseased mass with the hooked forceps, he notched the border of the tongue with a pair of straight scissors, and finally detached the diseased portion by a semicircular cut with a pair of curved scissors. The large gap made in the tongue was greatly diminished by the immediate retraction of the parts, which served also to check the hemorrhage from two divided arteries that it was found impossible to tie.

Occasionally we meet with cases of *chronic hypertrophic enlargement of the tongue (glossocoele)*, such, even, as to keep the organ protruded from the mouth, give a disgusting appearance to the face, and occasion troublesome excoriation of the integuments by the constant dribbling of the saliva. Lassus recommended the application of leeches and pressure in these cases, in the hope of gradually bringing down the tongue to its natural dimensions. This practice, conjoined with the internal use of iodide of potassium, &c., may succeed when the enlargement is not extreme. But if it be of considerable magnitude, and of several years' standing, as in a case related by Dr. T. Harris,* it is best to extirpate the protruded part by one of the processes above mentioned. Dr. Harris, finding the attempt to detach it by ligature unsuccessful and excruciatingly painful, on account of his not being able to

completely suspend the circulation in the included part, excised a Λ shaped portion with a catling. The hemorrhage which followed was not profuse, and the recovery was complete.

Removal and atrophy by ligature.

The isolation and strangulation of a diseased portion of the tongue have been practised with two objects in view:—that of effecting sphacelus, when the affection was of such a nature that it was impossible to restore the part to a healthy condition; and that of merely obstructing the circulation, so as to cause atrophy, and by that means arrest the progress of a disease which was not believed to be positively malignant. The latter proposition has been carried into practice by MM. Mirault and Maingault, but experience has not yet decided it to be a measure deserving of much reliance.

Erectile tumours are sometimes observed on the dorsum and sides of the tongue. These, when small, it has been directed to remove in the ordinary manner—by the introduction of a double ligature under their base with a curved needle, dividing it at the loop, and tying a ligature on either side of the tumour so as to strangle it at its base. In consequence of the firm structure of the tongue, the author has found it difficult to effect complete strangulation in this manner, and gives a decided preference to the use of the double canula of Levret with a well annealed iron wire. In this way he has successfully removed two tumours of considerable size, occupying one border of the tongue near its root.

Process of the Author.—Two tenacula are to be hooked in deeply at different points through the base of the tumour, so as to elevate the diseased structure and at the same time draw the tongue forwards. Over the handles of the instrument, the wire loop is to be passed, and placed so as to grasp the base of the tumour below the hooks. The wire is then to be drawn as tightly as possible with a pair of forceps, and secured to one arm of the instrument as directed at page 14. If the base of the tumour can by this means be pinched up into a narrow pedicle, the hooks may be at once removed—if not, one of the hooks should be left in place for a few hours, with the point retracted so as not to irritate the palate, after which time the wire is to be again drawn and the hook definitely removed. The wire is afterwards to be daily tightened, till the loop is loosened by the sloughing of the mass, which takes place in from three to five days, according to the size of the part embraced.

Process of Arnott and Cloquet for the destruction of the lateral half of the tongue by ligature.—A small incision is to be made in the middle line between the jaw and os hyoides, and the geniohyoid, and the genio-hyo-glossus muscles of the two sides separated slightly from each other. A curved needle, mounted on a handle and pierced with an eye near its point, is passed upward so as to be brought out in the middle part of the base of the tongue. Two strong ligatures are now to be passed through the eye, and the needle retracted so as to bring the ends of the ligatures through the substance of the tongue to the opening below the chin. From the same place, the needle is again to be carried upward and brought out near the frenum. The other ends of the ligatures which hang from the mouth are now to be passed into the eye of the needle, and likewise drawn down to the orifice of the cutaneous incision. Two loops of ligature now rest upon the dorsum

* Am. Jour. Med. Sci., Nov., 1830.

of the tongue. One of these is made to embrace the organ in a longitudinal direction, and the other in a transverse, so that when firmly tightened, they will strangle a portion of the tongue between them. A small incision should be made in the point of the tongue for the longitudinal loop, to keep it from slipping.

M. Mirault has modified this process, with the object of producing atrophy of the diseased part by a partial strangulation. From the puncture below the chin, he introduced a large needle threaded with a strong ligature, upwards through the base of the tongue—the tongue being forcibly drawn forwards. The needle was again passed, but in the opposite direction from above downwards, and from the side of the tongue to the orifice below the chin. A single loop was thus thrown laterally over the tongue, the ends of which loop were tightened below by a *serre-nœud*.

A modification of this process of ligature proposed by M. Main-gault, appears to be entitled to a preference over the two preceding, and requires the making of no external incision. The needle and ligatures are to be passed through the tongue from the cavity of the mouth, as shown in fig. 4; the process is fully detailed in the explanation of the plate.

EXCISION OF THE UVULA.

This operation is rendered necessary in various chronic affections of the lining membrane, followed by elongation, hypertrophy or degeneration of this pendent part. A merely dropsical swelling, resulting from the accumulation of serum in the submucous cellular tissue, which I have seen sometimes so large as to form a semi-transparent floating tumour, blocking up the fauces, irritating the tongue by its pressure, and producing a sense of suffocation, may be removed by merely clipping or puncturing the membrane freely with the scissors or bistoury. Excision may be practised simply with the angular uvula scissors of S. Cooper; but the pinching action of the scissors drives the uvula backwards against the bar, so that it is seldom neatly divided at a single stroke: or the point of the uvula may be seized and drawn forwards with a pair of toothed forceps or a hook, and the section made with the common scissors or the probe-pointed bistoury. Except in cases of degeneration, where all the diseased part must be extirpated, the division should be made a few lines below the corresponding margin of the velum, as this will suffice to remove all the irritation arising from its elongation and enlargement. The tongue, if *necessary*, may be held down with the finger or a spatula, and it may *possibly* be requisite in cases of children, though I have never found it so, to keep the teeth asunder by wedges between the grinders.

A variety of instruments have been devised to render this little and common operation easy. By far the best of these, according to my own experience, is the proper uvula-scissors, with a pair of serrated spring forceps attached below the blades. The forceps are to be opened with the blades, and set by a movable lever attached to the shanks. In this state the instrument is carried into the mouth, with the blades on either side of the uvula. The operator now pauses a moment till the levator muscles, which are at first excited, relax and drop the uvula between the blades, which are then to be slowly closed. As the handles move towards each other, the lever recedes, so as to loosen the spring forceps, the

teeth of which close upon the lower part of the uvula, and hold it firmly while it is cleanly excised without risk of slipping from the scissors, or any necessity of repeating the attempt. When the spring has closed, which is at once known to the operator, the instrument should be slightly retracted, bringing with it the tightly pressed uvula, so as to remove the ends of the scissors from the back part of the palate; and this should be done without interrupting the stroke. The detached piece of the uvula is brought away in the grasp of the forceps.

EXTIRPATION OF THE TONSILS.

The tonsils, though frequently inflamed, suppurating, enlarged and indurated, are very seldom the seat of malignant disease; and if such should be the case, but little relief can be expected from their removal by operation. In affections of the former class, the surgical aid required may be employed with nearly a positive certainty of success. If the parts be recently inflamed and swollen, so as to obstruct deglutition and breathing, scarification will sometimes be found beneficial; if an abscess have formed in its substance, this may be opened and its contents discharged. Both these operations may be performed with a bistoury *cachè*, or even with a scalpel somewhat longer and narrower than usual, care being taken to make the incisions on the most prominent place, so as not to injure the neighbouring parts. Tumours of the tonsils from hypertrophy and chronic induration, is a very common consequence of repeated cynancheal inflammation, and from their situation at the union of several most important cavities, will require to be removed, if so enlarged as to obstruct and impair the functions of these parts. Complete extirpation, however, is rarely necessary. The wound heals kindly, without reproducing the tumour, and it usually suffices to cut away that portion only which protrudes beyond the pillars of the velum pendulum palati. If an attempt be made to extirpate the base between the pillars, the internal carotid, which is only separated from it by the thickness of the walls of the pharynx, will be in danger of injury—a circumstance which formerly induced practitioners to employ in place of cutting instruments, strangulation by ligature, or destructive cauterization; these methods, however, have been found so difficult, tedious and painful, as well as dangerous, from the protracted irritation they occasion, that they have been utterly abandoned.

The following is the usual method of operation resorted to by European surgeons. The patient is seated on a chair, his head held by an assistant, and the face turned toward the light. The mouth is opened as widely as possible; a piece of cork may be introduced between the molar teeth, and the tongue held down with a spatula, if the subject of the operation be a child. The enlarged gland is then drawn off from the palate with a tenaculum, or, which is better, with the hook forceps of Museux, which is less likely to tear out. The division is effected with a scalpel or probe-pointed bistoury, wrapped half-way from its heel to the point with a strip of adhesive plaster. Great care must be observed to avoid wounding the palate. If the incision is not made too deep, the bleeding is usually inconsiderable, and readily checked by gargling with cold water. As the common straight knife is used here to great disadvantage, various modifications of its

shape have been suggested, the best of which perhaps is that of Mr. Yearsley. The knife of this operator consists of a short strong blade, with a hawk bill, and is angularly bent in the handle. The use of the scissors is by some surgeons preferred to that of the knife. The best instrument of this kind is that invented by Professor Smith, of Baltimore, the blades of which are curved on the flat, and bent like a hawk bill towards each other so that the points cross when the instrument is shut. Two small steel points are in addition attached to the side of each blade so as to catch the portion excised, and prevent its falling on the glottis. The use of the hook and knife has been objected to as hazardous, on account of the general spasm of the muscles of the mouth following the introduction of the hook. Various instruments have in consequence been devised to render the operation more safe and easy, the best of which are of American invention. Of these, the only ones which are really well suited to the operation, according to the experience of the author, are the guillotine instrument of Dr. Physick as modified by Dr. J. K. Mitchell; the ring instrument of Fahnestock, with a knife nearly circular in shape; and another—a modification of this, consisting mainly of the attachment of a pair of forceps with a spring upon the front, which of themselves draw out the tumour from between the half arches so as to insure the removal of a sufficiently large portion, and with such an alteration in the shape of the handle, that the two first fingers can retract the sliding blade.

The instrument last described, which is shown applied at Plate LV. fig. 6, has moreover the advantage of requiring the use of but one hand. It is employed in the following manner. The instrument is to be set with the knife (*d*) hid between the narrow elliptical plates of steel (*a*) which cover it, and the forceps (*e*) opened and pressed down upon the spring (*g*), and secured in this position by the insertion of the shanks into a mortise (*f*) in the sliding bar (*c*) which moves the blade (*d*); it is then carried into the mouth and over the protuberant gland, which will be found sometimes with a process pendent on the side of the pharynx, round which the instrument must be slid. When the instrument fairly embraces the gland, and is well pressed up to its base, the vertical bar (*c*) is retracted by the first two fingers which rest upon it. This loosens the forceps, which close upon the tumour by the action of the spring between their shanks, and at the same time draw it farther within the circuit of the knife by the reaction of the spring (*g*), which had been forcibly depressed in setting the instrument. The continued retraction of the blade excises the tumour, which is brought away in the grasp of the forceps. For the tonsil gland of the right side, it will be most convenient to apply the instrument with the left hand. No instrument is required to depress the tongue or hold the mouth open—the fore finger of the other hand answering better than anything else when any depression is needed. All the precaution necessary in the operation, is to accustom the fauces to the contact of instruments, by having them touched frequently for several days previously with the handle of a spoon, and to avoid wounding the half arches of the palate, which, as shown by Dr. I. Parrish, might be followed by some defect in enunciation.

The ring instrument of Dr. Fahnestock will, from the smallness of its dimensions, be found particularly appropriate in operations upon children, when the tumour is somewhat pendulous. When

it is merely round and large, without being pendulous, there is sometimes with this instrument, which has no contrivance for drawing the tumour through the ring, a difficulty in removing a sufficiently large portion. In the forming state of these tumours, and especially in scrofulous children, astringent applications and occasional touching with lunar caustic, will frequently suffice for their removal, without resorting to the use of cutting instruments.

STAPHYLORAPHY.

This operation is an invention of modern surgery. Though the idea of reuniting the two edges of a fissured velum palati was entertained by the older surgeons, and is said to have been successfully performed by M. Le Monnier in 1764, it is to Græfe, of Berlin, and Roux, of Paris, who performed their first operation of the kind in 1816, that we are indebted for the examples which introduced the practice into general use.

A congenital division of the palate, a fissure resulting from a wound of the organ, or a destruction of a part of the substance by ulceration impairing the clearness of articulation, are the common causes which require the performance of this operation.

In simple staphyloraphy the principle of the operation is the same as in simple hare-lip, viz., to remove the margins of the fissure with a cutting instrument, and to hold the raw edges in contact with each other till there is time for union to take place. The operation may consequently be divided into three stages. 1. The removal of the old margins of the fissure. 2. The drawing in of the ligature; and 3. The uniting of the fissure. As the performance of the operation is somewhat difficult, and requires not only careful and delicate manipulation on the part of the surgeon, but perfect willingness and self-command on that of the patient, it cannot be attempted with advantage much before the age of puberty. For a week or two previous to the operation the root of the tongue and the velum palati should be touched frequently with a spatula or spoon, in order to diminish the natural irritability of the parts, and dispose them better to the manipulation necessary during the operation. If the fissure extend but a little distance above the uvula, or in case it reach near to the hard palate, and the velum is not found so defective in extent of structure but that its separate portions may easily be drawn together, the operation is comparatively easy, and offers a fair prospect of success. If, however, the fissure be very large, and the lateral margins of the velum so much contracted as to be almost lost in the mucous membrane of the fauces, the difficulties will be greatly increased, and the chance of success diminished, in consequence of the tendency to muscular spasm and ulcerative inflammation occasioned by the tension which has been necessary to bring the parts together. Cases of this description may, notwithstanding, be made by proper management to unite perfectly in the end; two of which, successfully treated, have been reported by the author in the Amer. Journ. of the Med. Sciences for June, 1843. Of the various processes that have been devised for the cure of this deformity, it will suffice to mention the following, in which are contained the leading peculiarities of the whole.

Process of Roux. (Pl. LV. fig. 1.)—The apparatus required consists of three flat ligatures, each formed of two or three threads waxed together; six small curved needles affixed to the ends of

the ligatures; a needle holder, or *port-aiguille*; a pair of ring-handled dressing forceps; a straight button-pointed bistoury, and a pair of angular scissors.

1. *Application of the ligatures.*—The patient is to be seated with his face to the light, his head thrown back and supported on the chest of an assistant, and the mouth maintained wide open with a linen compress or a speculum between the teeth, unless sufficient confidence can be reposed in the voluntary efforts of the patient to keep it open. The surgeon, with the forceps in his left hand, takes hold of the right half of the velum, and in-

troduces with the right hand, through the cavity of the fissure, the *port-aiguille* armed with one of the threaded needles. Pausing a moment for the spasm occasioned by this step to subside, the operator passes the needle from behind forward through the velum at the distance of three or four lines from the margin of the fissure. It is then seized with the dressing forceps; the hold which the *port-aiguille* has of the heel is relaxed by the retraction of the slide, and the needle is drawn out through the mouth, bringing with it the ligature. The patient is now allowed to rest for a time, and to rinse out the mouth. The needle at the opposite end

PLATE LV.—STAPHYLOGRAPHY. BRONCHOTOMY.

STAPHYLOGRAPHY.

Fig. 1.—(*Process of Roux.*) *Passing of the needle from the back to the front portion of the palate.*—Two ligatures (*a, b*), the upper and the lower, are represented already inserted. They have been passed from behind forwards with a needle attached to each end, precisely as in the process shown for the introduction of the middle thread. The right lip of the fissure is seized and held firm with the ring-handled forceps (*c*) in the left hand of the surgeon. The needle, which has been securely fixed in the needle holder or *port-aiguille* (*d*), has been passed through the velum from behind forwards. The slide, against which the thumb of the hand (*e*) rests, is now loosened and the *port-aiguille* detached from the needle. The needle is then drawn through, bringing after it one end of the ligature, which is attached to its eye.

Figs. 2, 3, 4.—(*Process of the author.*)

Fig. 2.—*Excision.*—The operator takes hold of the uvular end of the fissure with the spring forceps of Assalini (*a*), and passes the point of the double-edged knife (*b*) through the velum, and runs it up to the apex of the fissure so as to detach all the rounded edge.

Fig. 3.—*Introduction of the needles.*—In this drawing, which was taken at an operation of the author, the fissure was of the largest size. Four permanent ligatures were employed. The one shown as an example of the mode of introduction, is the second one counting from the bottom, and is intended merely as a conducting thread.

c. Physick's artery forceps, grasping the heel of the needle.

d. A pair of convenient toothed dressing forceps, with which the needle is grasped and withdrawn, bringing with it the ligature.

Fig. 4.—*Lateral incisions after the manner of Dieffenbach, to facilitate the approximation of the edges of the fissures.*—The three ligature threads, which were all that were applied in this case, are seen knotted over the middle line, causing by the tension they exert the gaping of the incisions on the front part of the velum.

STAPHYLOPLASTY.

Fig. 5.—(*Process of the author.*)—A hole existed in this case near the centre of the hard palate, establishing a communication between the mouth and nose. Two irregular quadrilateral flaps were raised, as seen in the drawing, from the mucous covering of the sides of the roof of the mouth. These were reversed upon the orifice with their mucous surface upwards, attached to each other by two points of interrupted suture, and forced firmly up against the margin of the bony orifice (which had been previously made raw with a knife), by a curved hare-lip pin, the convexity of which presented upwards and corresponded with that of the palatine arch. The wrapping of the ligature round the pin carried the flaps firmly up against the orifice, so as to facilitate their adhesion to the raw margin of the latter. The mucous membrane of the sides of the flaps was partially shaved with the knife before they were reflected upwards.

EXCISION OF THE TONSILS.

Fig. 6.—*Excision of enlarged tonsils with the improved tonsil instrument.*—For want of space the handle of the instrument is not shown. The handle is formed by giving to the end of the shaft two rectangular turns, so as to suit it well to the grasp of the hand.

a. Shaft of the instrument, continued on so as to form one of the elliptical plates between which the knife slides.

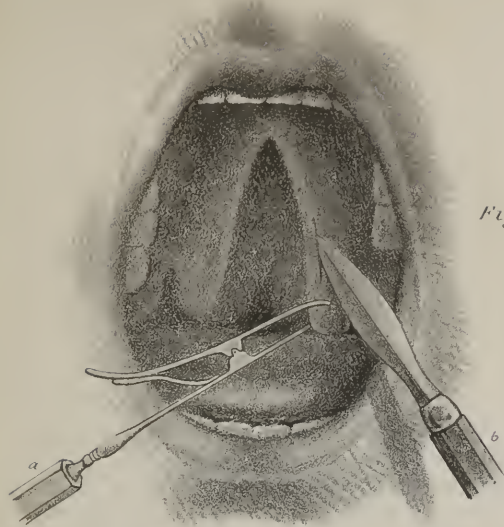


Fig 2

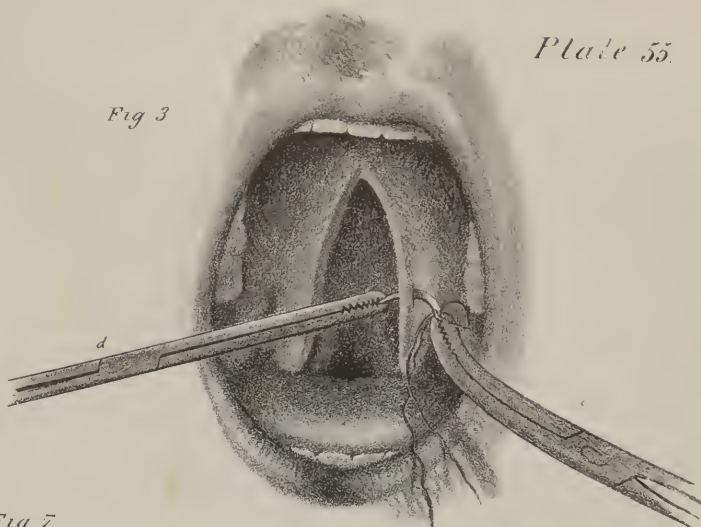


Fig 3

Fig 7

Fig 4

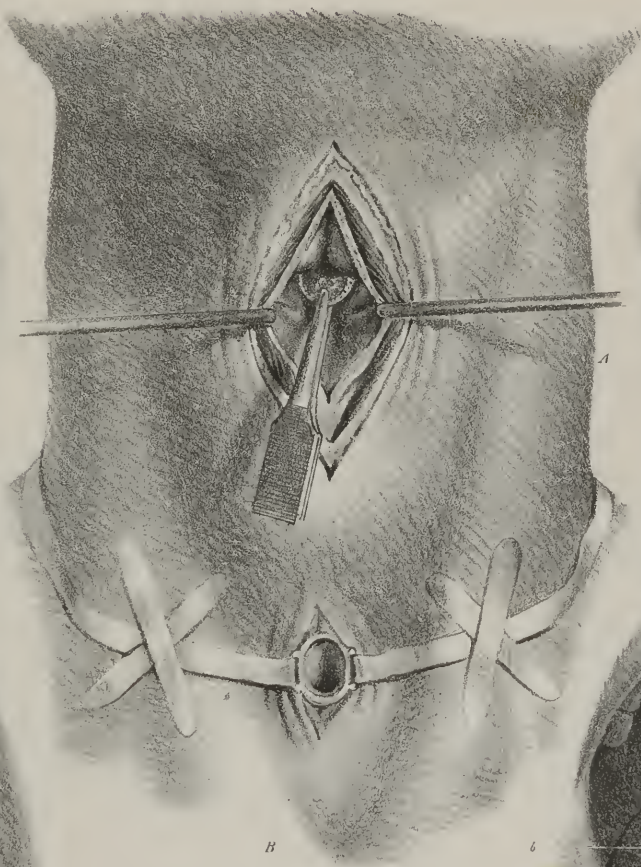
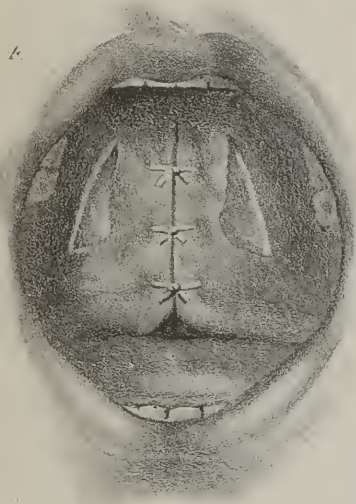


Fig 5

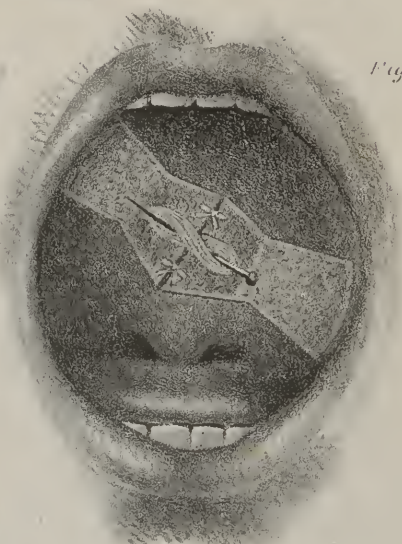


Fig 6

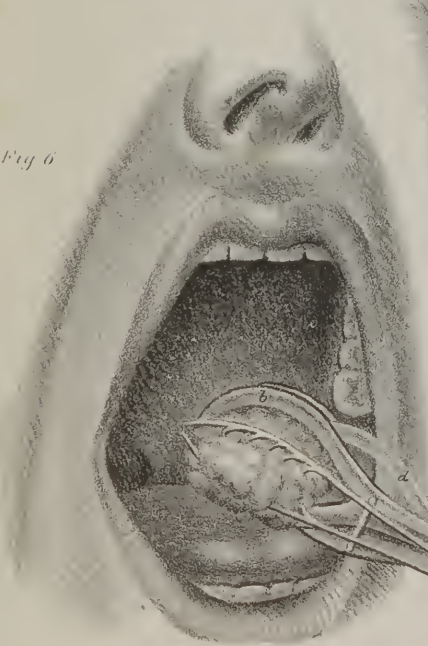


Fig 8

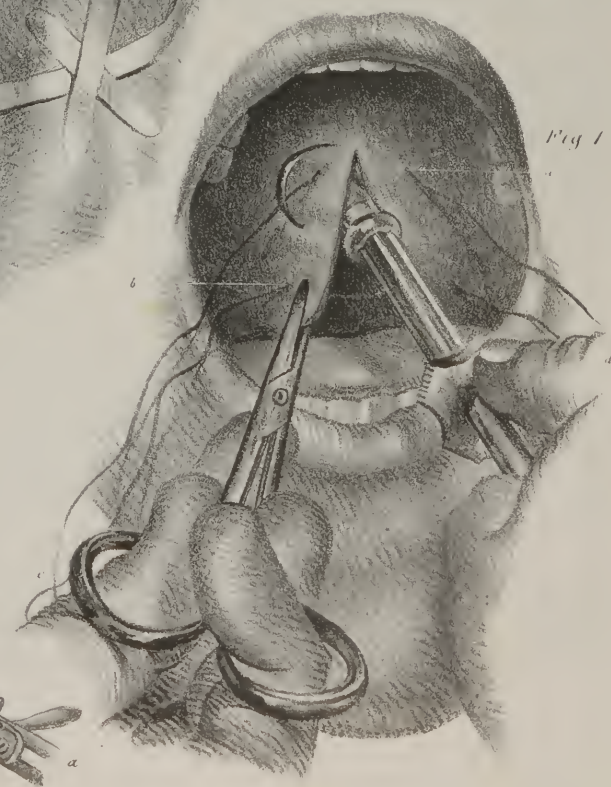


Fig 9

of the same ligature is next fitted to the other margin of the *port-aiguille*, and carried by a similar process through the right half of the velum. The two ends of the thread are left hanging at the corresponding angles of the mouth. The lower ligature, or that near the free border of the palate, is to be placed first. The two other ligatures are introduced in a similar manner, the middle one being inserted last.

2. *Excision of the edges*.—The loops of the three ligatures are to be depressed downward and backward into the pharynx, so as to avoid cutting them in the removal of the edges of the fissure. The operator then seizes the left angle of the velum with the forceps, so as to make it tense, and begins with the angled scissors the incision of the edge, which he completes with the button-pointed bistoury, running the latter instrument up with a sawing motion two or three lines above the apex of the fissure, in order to detach a piece from half a line to a line broad, comprising the rounded edge of the fissure. The same process is then to be repeated on the other side.

3. *Knotting the ligatures*.—M. Roux effects this with the fore finger of each hand introduced back to back. The lower ligature is to be secured the first. When the first fold of the knot is drawn, an assistant is to grasp it with the forceps to prevent its relaxation, while the second and final turn of the thread is made. The upper and middle ligatures are successively knotted in the same manner—the surgeon observing the precaution to draw each knot tighter than would be necessary merely to close the fissure at that point, in order that the intervening spaces may be brought completely in contact.

The operation is now terminated. The patient is to be kept perfectly quiet, to maintain the mouth closed, to take no solid aliment, and nothing scarcely but a little fluid, and that at long intervals. A piece of ice or a slice of lemon taken from time to time will serve in a good degree to subdue the feeling of thirst. All coughing and sneezing, or even spitting, is to be obviated as much as possible, and everything in fact that will be likely to excite motion of the muscles of the velum—even so much as the swallowing of the saliva, which should merely be conducted out with the tongue and received upon a cloth between the teeth. On the third or fourth day, the knots of the two upper ligatures may be cut, and the ligatures carefully withdrawn. The lowermost ligature, or that near the uvula, should be left for two or three days more. If, after the division of the knot, the ligature does not readily slip, it is better to postpone its removal to the following day than run the risk of breaking up the adhesions by the effort. A gap, even when the case has gone on well, is frequently left at the upper part of the fissure. This is subsequently to be closed by cicatrization under the stimulating influence of lunar caustic, (Roux,) or the soluble nitrate of mercury, (Cloquet.)

The objections made to the process of Roux, are, 1, the awkwardness, irritation and imprecision, necessarily attendant upon the passing of the needles from before backwards, and from a surface to which the eye cannot reach; 2, the difficulty of excising the margins after the introduction of the ligatures, which, by the depression of their loops in the pharynx, keep up a constant feeling of nausea and irritation; 3, the great length of time required, from these various causes, in the performance of the

- b. Second plate, attached to the shaft of the instrument by screws.
- c. Vertical bar, with which the elliptical knife (*d*) is retracted by the first two fingers, which, when the knife is applied, rest upon the bar.
- e. Shanks of the spring forceps, (the spring being included between the shanks,) intended when the instrument is set to be pressed together and held in the mortise (*f*) of the vertical bar (*c*). The forceps terminate at the other end in serrated curves.
- g. Elastic spring, fastened upon the body of the instrument with a transverse bar on the end next the knife intended to throw up the toothed forceps and cause them to protrude the gland within the circuit of the knife. The instrument is shown as in the act of excising the gland. The vertical bar (*c*) has been retracted; this loosened the shank of the spring forceps, so as to allow its serrated extremities to come together, and the spring (*g*), which had been depressed to raise the shanks of the forceps up to the mortise in the vertical bar, reacts so as to protrude the gland. These movements, which take place instantaneously, are succeeded by the continuous retraction of the knife and the incision of the tumour.

BRONCHOTOMY.

Fig. 7.—Two modes of performing this operation are shown in the figure, the upper one of which is denominated Laryngotomy, the lower Tracheotomy.

- (A). *Laryngotomy*.—The operation is supposed to have been performed for the removal of a piece of coin, resting in the opening of the glottis. An incision has been first made through the skin and superficial fascia; the sterno-hyoid muscles have then been separated, and the thyro-hyoid membrane and the thyroid cartilage cut through on the middle line. The margins of the wound have next been drawn asunder with blunt hooks, so as to expose the interior of the cavity of the pharynx. A pair of forceps has been introduced for the removal of the foreign body.
- (B). *Tracheotomy*.—The canula of M. Bretonneau, (seen in full at fig. 8,) shown inserted after the performance of tracheotomy according to the process of this surgeon. It is secured by two ribbons attached to its rings, and knotted behind the neck. Two strips of adhesive plaster are applied in the form of a cross over each sterno-cleido-mastoid muscle, to keep the anterior extremities of the ribbons in place.

operation, which has frequently been known to occupy one and a half to two hours.

These difficulties will be found dissipated in a great degree by the following process, in which the author has been enabled to complete it under favourable circumstances in less than half an hour.*

Process employed by the Author. (Pl. LV. figs. 2, 3, 4).—The apparatus necessary is very simple. A pair of Assalini's spring forceps, a double-edged knife, or the ordinary cataract knife of Wenzel with a handle somewhat longer than usual, Physick's artery forceps, a pair of ordinary dressing forceps, and six stout short curved needles,† lancet-shaped at the point. The needles should be arranged in a cushion in two rows, three being threaded with a fine silk conducting thread, and three with broad ligatures, with which the closure of the fissure is to be permanently made.

A vessel of alum water should be at hand for the purpose of arresting the bleeding, which would obscure the parts. The patient is to be placed as in the process just described.

1. *Excision.* (Fig. 2).—The operator, with the spring forceps in the left hand, takes hold of the uvular margin of the right portion of the velum, and puts it on the stretch. The point of the double-edged knife is then to be entered just above the point of the forceps, from before backwards, and the knife carried up a line above the apex of the fissure, so as to detach the rounded border of the fissure in a narrow strip. The knife as well as the forceps is then withdrawn, leaving the strip as yet adherent at its upper and lower ends, so as to have no floating point to irritate the passages. The patient is now to rinse out the mouth. A similar operation is then repeated on the opposite margin of the fissure; but at this time the knife is run up to cut into the former incision near its top, and then brought down so as to detach the lower end of the loosened strip by cutting at the outer side of the hold of the forceps. The forceps, which retains its hold of the A shaped marginal strip is now retracted so as to straighten out the piece, which remains attached only at the point of the uvula of the left side, from whence it is at once to be separated with the point of the knife. The excision of the edges, which is considered by Roux the most difficult part of the operation, is in this way readily effected.

2. *Introduction of the ligatures.* (Fig. 3).—These are all to be introduced from before backwards, so that the surgeon can see that they are placed exactly opposite to each other in order to avoid any puckering of the velum when they are tied, and at the proper distance from the excised margin. As soon as the bleeding is checked by the astringent gargle, the introduction of the ligatures is commenced. The three needles threaded with the permanent ligatures are to be first passed, and on the left side, and in the same order of insertion as in the process of Roux. The needle held by its shank in the grasp of the artery forceps,‡ is then presented with its point perpendicular to the velum, the

handle of the forceps being carried for this purpose to the opposite corner of the mouth. If the needle is sharp at the point, it passes in this way readily through, without the necessity of making any tension of the part with the forceps, thus obviating one great cause of irritation and the disposition to cough or choke when any strain is made upon the velum. As the needle penetrates, the handle of the forceps is brought towards the opposite corner of the mouth; the point of the needle, which is now obvious in the fissure, is grasped with the dressing forceps held in the other hand for the purpose; the artery forceps is removed, and the needle is carried through so as to be detached behind the palate, and brought out either with the heel or point foremost, as is found most convenient. Having passed the three permanent ligatures in this way through the right side of the palate, the tails are to be brought out and lodged separately between the fingers of an assistant. The same process is repeated on the opposite side for the passage of the three fine temporary or conducting ligatures. It now remains to bring the posterior ends of the three broad or permanent ligatures of the right side through the punctures which have been made with the needles on the left. This is readily effected by knotting together the back ends of the corresponding ligatures of the two sides—which are drawn out of the mouth for this purpose—flattening the knot with a squeeze of the forceps, and pulling upon the fine conducting thread so as to carry the knot and the back end of the ligature of the opposite side with it, the end of the fore finger being pressed as a point of support upon the velum as the knot is passed with a slight twitch through the puncture.

3. *Knotting the ligatures.*—The permanent ligatures have now been carried through both sections of the velum, and nothing remains to be done but to wipe away the glairy mucus from the threads, and tie them as in the process of Roux. The ends of the ligatures, as each respective one is tied, are to be detached close to the knot with a pair of curved scissors.

Remarks.—Though there are many difficulties to encounter in the after-treatment that may render the operation fruitless, as the neglect on the part of the patient to observe absolute silence, the occurrence of paroxysms of coughing, sneezing, etc., yet when the patient is docile, and the simple plan above described is employed, it will not be found one of any peculiar difficulty to any person accustomed to the performance of such as require some nicety of touch. I can readily conceive, however, from the delicacy of the operation, and the length of time required to perform it, that great dexterity and skill on the part of the surgeon, and firm resolution on the part of the patient, will all be needed, as described by writers, when the complicated and cumbersome instruments frequently advised are employed, five of which were used by Græfe merely for tying the knot. The most difficult part of the operation is considered, as has been before mentioned, to be the excision of the edges of the fissure. But this is dependent on the method in which it is done, and will especially be found the case where the ligatures are first completely passed, the loops depressed in the throat, and the edges made raw with the scissors and bistoury, as practised by M. Roux. The leaden ligature of Dieffenbach, the simple long curved needle set in a handle used by many surgeons, the ingenious modifications even of the old *port-aiguille* by Messrs. Du-

* Vide Amer. Jour. Med. Sci. for Jan., 1843.

† When the fissure is large, I have found it better to have eight needles, and apply four sutures for the purpose of closing it.

‡ To Dr. Wells, of Columbia, S. C., and Professor Mütter, belongs the credit of having introduced the use of this simple instrument for the passing of the needles, in place of the more cumbersome contrivances commonly used.—Vide Am. Jour. of Med. Sci., 1841.

pierris and Guyot, cannot be compared with the instruments I have described above, in respect to the facility and rapidity with which the ligatures can be passed—in reality the only difficult part of the operation.

Modification of the operation, rendered necessary when there is deficiency of structure or the fissure is unusually large (Pl. LV. fig. 4).—If it is found impossible to bring the margins of the fissure together at all, or without producing excessive tension, it is necessary to find some method of elongating the soft parts. For this purpose, M. Roux made a transverse section of the palate along the posterior border of the palatine bones. M. Bonfils made a plastic operation after the Indian method, by dissecting up a flap of a proper shape from the mucous membrane of the arch of the palate, reversing it so as to allow it to hang by its posterior part, and fastening it by suture to the margins of the fissure of the velum. To remedy this deficiency of structure in extreme cases, Dr. Mettauer,* of Virginia, has recommended as a preparatory step, repeated lateral incisions through the substance of the velum, leaving spaces to fill up by granulation, after interposing a piece of buckskin or soft sponge between their edges. By this means, as he asserts, the pliable surfaces of the velum will be increased in extent so as to allow of their being afterwards drawn together, without causing the ligatures to cut out. The plan of Dieffenbach, (fig. 4,) which is but an imitation of the Celsian plastic method, is the one which the author has been most disposed to rely on in practice, and has found to answer well in two cases of large fissure of the palate. This consists in making lateral longitudinal incisions of a length proportioned to that part of the palate found most deficient. These incisions should be at the distance of four or five lines from the margin of the fissure. The edges of the fissure are then to be excised and secured as in the ordinary process, and if any difficulty should be still found in closing it, the elongation may be increased by dissecting a little at the inner margins of the incisions.

In one instance, after closing the parts, the author, finding the tension so great as to induce him to think that the ligatures would cut through before union could take place, made a vertical incision with a double-edged knife, passing the instrument entirely through either half of the velum, so as to relieve the tension, as was shown by the gaping orifices left, and cut off the tendons of the palate muscles which, from having been unduly stretched, there was reason to fear, would contribute to the strain upon the ligatures. The relief afforded by these incisions seemed to facilitate the process of cure; this did not take place perfectly, however, without the necessity of having to repeat partially the process of operation.

Fissures or openings existing in the bony portion of the palate. (Pl. LV. fig. 5.) These are seldom thought to require an operation, as they may be closed by an obturator, so as to prevent any very obvious imperfection of speech. But in some instances, an operation of the kind shown in the drawing may be practised with advantage for the purpose of closing them up with living tissue. This, however, belongs to the class of plastic operations, and will be noticed under that head.

V. OPERATIONS UPON THE NECK.

Under this head are considered, 1, Bronchotomy, 2, Catheterism of the Œsophagus; and 3, Œsophagotomy.

BRONCHOTOMY.

This term, though etymologically inappropriate, has been long employed as a generic appellation for operations upon the air passages, whether the opening made be in the trachea (*Tracheotomy*), in the larynx (*Laryngotomy*), partly through both these structures (*Laryngo-tracheotomy*), or in the crico-thyroid or hyo-thyroid membranes. Bronchotomy is an old operation, and is neither difficult of performance nor directly dangerous as regards its immediate results. But as it is performed usually only in cases of extremity, the fatal consequences that ensue from the previous condition of the patient, are liable without explanation to be placed to the responsibility of the operator. The performance of the operation has been recommended for the fulfilment of several indications.

1. *For the removal of foreign bodies from the air passages*, when they cannot be dislodged by exciting expectoration or vomiting or by suddenly reversing the patient with the head downwards. In the well known case of Mr. Brumel, Sir B. Brodie was unable to dislodge a guinea which had slipped into the wind-pipe, by suddenly reversing the patient by the aid of machinery, in consequence of the coin exciting spasmodic action as it fell upon the chink of the glottis, threatening suffocation. The operation of tracheotomy was then performed, to guard against this danger. The reversion of the head of the patient downwards was then made with better success; the coin passing the glottis, and falling by its own weight out upon the floor.

2. *For the removal of the false membrane, or diphtheritic effusion of croup*, in which the ordinary methods of treatment have failed to afford relief. The opening of the trachea has latterly been strongly recommended, under these circumstances, by MM. Bretonneau and Trousseau. The success of the practice, however, in the hands of these gentlemen, does not appear to have been great, as they were enabled to save, according to their own reports, only one case in three of those operated on; and in the hands of most other surgeons, the proportion of cures effected has been still less.* The advocates of the operation assert, however, that the cause of its not succeeding more frequently, is nearly always the consequence of its not having been performed sufficiently early. We may not only succeed in removing by this operation, according to M. Bretonneau, the membranous concretions already formed, but, by keeping a tube in the orifice, get access to the passage so as to take away those subsequently developed, and check their tendency to reproduction by the introduction of calomel in powder, or the instillation of a few drops of a solution of lunar caustic.

3. *For anginose affections, attended with imminent danger of suffocation.*—In cases of acute inflammatory swelling of the ton-

* Amer. Journ. of Med. Sci., Feb. 1838.

* Of a hundred and forty cases collected in Froriep's Notizen for Feb. 1840, in which the operation was performed for *inflammatory affections* of the air passages, only twenty-eight of the patients recovered, and a hundred and twelve died.

sils, or of the upper surface of the larynx, relief will usually be afforded by some deep longitudinal incisions in the swollen surface, without recurring to bronchotomy, which has been recommended in these affections when the turgescence is so great as to threaten suffocation. If the swelling is seated at the top of the larynx, the incisions should be made in the upper surface of the back part of the tongue. In *œdematous angina*, where there is a serous effusion under the mucous folds of the lips of the glottis, so as to more or less obstruct the chink, the danger of suffocation is more immediate. It has been advised, in cases of this sort, when other remedial measures fail to afford relief, either to scarify the tumefied membrane with a sharp-pointed bistoury wrapped with a thread to near the point, and carried along the finger over the back of the tongue,—to introduce a tube through the glottis from the mouth,—or to perform the operation of bronchotomy and insert the canula. The last process is, in this serious affection, the most to be relied on, as it insures the freedom of respiration, and gives time for the removal by absorption of the fluid effused round the lips of the glottis; little hazard appears to attend its performance, and it has proved successful in almost every case in which it has been resorted to for this indication.

4. *For diseases of the larynx.*—Wounds, syphilitic ulcers of the larynx, and strictures of the glottis, which in general are so little amenable to the ordinary plans of treatment, are said by Purdon, Velpeau, Bulliard, Porter and others, to have been cured after the insertion of the canula by the operation of bronchotomy. Pressure on the air passages from foreign bodies in the œsophagus, from alimentary matter lodged in the upper orifice of the larynx, or from tumours on the exterior, have likewise in some cases rendered this operation necessary.

Operations.—There are three principal varieties of the operation described, viz: *Tracheotomy*; *Laryngo-tracheotomy*; and *Laryngotomy proper*, in which the opening may be made either in the crico-thyroid or hyo-thyroid membrane, or through the thyroid cartilage.

1. *Tracheotomy.*

Surgical anatomy of the trachea.—The cervical portion of the trachea is from two to two and a half inches long. It is covered, 1, by the skin and superficial fascia; 2, by the sterno-hyoid and thyroid muscles; 3, by the isthmus of the thyroid gland, which lies usually over the three or four upper rings of the trachea, and sometimes extends as low as the fifth. Between the lower edge of the isthmus and the sternum, is found a plexus formed by the inferior thyroid veins, several of which are of large size, and occasionally an artery known as the *middle thyroid artery of Neubauer*. The presence of these vessels is the chief cause of difficulty in the performance of *tracheotomy*. The trachea, as it descends in the neck, it must be remembered, recedes from the surface so as to be nearly an inch behind the top of the sternum.

Operation.—The instruments required consist of a small scalpel, a probe-pointed bistoury, a pair of blunt hooks, or some other contrivance for separating the lips of the incision, a canula, and a pair of forceps for the removal of foreign bodies. The patient is to be placed in the *recumbent* posture, with his chest raised and the head thrown back so as to extend the neck and draw up the trachea as much as can be done without increasing the dyspnœa.

The operator, placed upon the right side, steadies the larynx with his left hand, and makes in the middle line an incision through the skin and superficial fascia, from the cricoid cartilage to a point a little distance above the fossa at the top of the sternum.

He now separates the two sterno-thyroid muscles, partly with the point and partly with the handle of the knife, and finding no large vessels in the way, pushes up, or, if necessary, divides the isthmus of the thyroid gland; if the blood which flows from the veins necessarily divided in the last step is not soon checked, the vessels should be tied. Before opening the trachea, the operator should ascertain by feeling with the finger whether it is covered by any large vessels, or if there is any displacement of the lateral lobes of the thyroid gland, and if such be the case, have them carefully drawn aside before making the puncture. Previous to opening the trachea, it is well to follow the advice of Mr. Porter,* and excise a circular portion of the cellular sheath covering the trachea, for fear that if the trachea and fascia were opened together by a longitudinal incision, the orifices in the two structures would not correspond, and thus present a difficulty in keeping the new passage open. He now opens the third, fourth and fifth rings of the trachea, puncturing the tube with the point of the knife below the fifth ring, and running the scalpel upwards with the handle a little inclined to the sternum, so as to avoid injuring the posterior wall of the trachea. For fear of this latter result, some have recommended the use of a probe or button-pointed bistoury, to make the incision after the puncture of the tube.

Immediately before making the puncture, it is well to direct the patient to swallow his saliva, which renders the windpipe more tense and superficial. In children, where we cannot expect this effort to be made, the trachea should be made tense by a sharp hook inserted into it as directed by Mr. Liston.

Dr. Murray has proposed to excise a circular portion of the skin over the trachea, bending the patient's head forward for the purpose of raising a fold of the skin with the thumb and finger, and cutting it off with one sweep at the base. A tenaculum is then to be inserted between two of the rings so as to allow a circular piece of the trachea to be removed with the knife. He believes that this process, which has not yet been tried upon the living subject, would facilitate the performance of the operation, diminish the risk of the blood entering the trachea, and render it easier to keep the orifice open.

The checking of the hemorrhage, from the veins and arteries divided in the operation, requires particular attention. From six to eight ligatures are usually employed; they should be applied in general as above directed, as the vessels are cut, and before the opening of the trachea. But when the danger of asphyxia is great, it has been advised to puncture the trachea without stopping to tie the vessels. In such case the blood might be drawn by respiration into the trachea, so as to cause danger from suffocation, as happened in a patient of M. Roux, whose life was saved solely by the promptitude of the surgeon in applying his mouth over the tracheal wound, and clearing the trachea and bronchi by suction. But the principles which it appears to the author should govern the conduct of the surgeon in regard to this operation would be, under ordinary circumstances, to tie the vessels as directed in the text, and when from the urgency of the

* *Surgical Anatomy of the Larynx and Trachea.*

symptoms, time was not afforded for this, to puncture instantaneously the crico-thyroid membrane.

The separation of the lips of the tracheal wound is to be made with a pair of blunt hooks, or with a pair of forceps, or a sort of spring speculum. To diminish the elastic reaction of the divided rings, M. Malgaigne has advised a cross-cut of the fibrous membrane between the rings, at the two extremities of the incision.

If there is a foreign body to extract, and it be small and movable, it may be driven out by an expulsive cough, particularly if the membrane be excited by the introduction of a finger into the trachea; or, as it moves up and down with the respiratory efforts, it may be fixed by placing a small curette below it, and then withdrawn with a pair of small polypus forceps. But if the foreign substance is placed more deep in the orifice of one of the bronchi, and is found fixed, the wound is to be kept open, lightly covered with gauze to prevent the entry of crude particles floating in the air, and the patient placed in a room, as directed by Mr. Liston, in which the air is raised to the temperature it usually acquires in respiration, when drawn through the natural passages. The foreign body will usually be found by the following day dislodged spontaneously, and ejected through the lips of the wound. If it should not become spontaneously detached, it may be loosened and drawn forward with a bent probe or removed with a pair of forceps. Mr. Key succeeded in removing a sixpence from one of the bronchi of a lad, with a pair of forceps constructed for the purpose, long and slender in the blade, curved a little near the point, and bent at an angle in the handle.

If the object of the operation be to maintain respiration by an artificial orifice, a silver canula must be introduced into the wound and secured as shown at Pl. LV. fig. 7. At the moment of inserting the canula, the patient should be told to swallow the saliva, as the effort at swallowing raises the trachea and renders the place of puncture more superficial. It is of primary importance in reference to the success of the operation that the canula should be properly curved so as not to irritate the lining membrane, and be of such a calibre as will admit of the entry of a large column of air, which can alone render respiration easy. Those in common use are too flat and narrow. That of Bretonneau, which will be found most serviceable, is shown at fig. 8. It has been advised to cut out a circular piece of the trachea, for the lodgment of the tube, but this is seldom necessary. The precautions in reference to the protection of the opening and the warming of the air above mentioned, are to be particularly observed, after the insertion of the canula. For a short time after its introduction, an assistant should be on the watch, to prevent the obstruction of the tube by the secretions from the membrane, clearing them away as may be necessary, with a stout feather, or a small piece of sponge attached to the end of a small whalebone probe, as recommended by M. Trousseau. The canula in a few days ceases to irritate the trachea, and the wound cicatrizes round it; it is to be worn for a length of time sufficient for the cure of the disease which has called for the operation, whether that be a few weeks, six months, or a year. In some few instances, it has been necessary to retain the canula in the wound for several years together.

Several surgeons have endeavoured to simplify this operation by the employment of a tracheotome-trocar. The best of these

is one of a curved shape, devised by Mr. Hilton.* This instrument, says Mr. H., renders all previous incision of the integuments unnecessary, though this may be made if preferred, provided the necessity for immediate relief be not urgent. If, in introducing the trocar and canula, by chance any vessel should be pierced, its walls, he believes, will be so effectually compressed by the sides of the canula, as to prevent the possibility of any blood getting into the trachea.

2. *Laryngo-tracheotomy.*

This, which is sometimes denominated crico-tracheotomy, consists in a section of the cricoid cartilage and the upper rings of the trachea. The soft parts, including the isthmus of the gland, are to be divided as in the process above given, with the exception that the incision is to be begun at the lower border of the thyroid cartilage, and not extended so low in the neck; fewer of the superior thyroid veins will in consequence be injured. As soon as the crico-thyroid membrane is exposed, the little artery which crosses it is to be pressed aside with the finger nail so as to admit of the puncture being made below it; the bistoury with the finger pressing on its back is then run with the cutting edge downward so as to divide the cricoid cartilage and the three upper rings of the trachea. This operation is more commonly performed for the removal of foreign bodies from the larynx, than for the insertion of the canula. From the elasticity of the cricoid, it would be necessary to introduce the canula between the divided rings of the trachea.

3. *Laryngotomy.*

a. Section of the crico-thyroid membrane.—This is the operation of Vicq-d'Azyr, and consists merely in a transverse section of the crico-thyroid membrane. It is in fact but the first stage of the preceding process, with the exception that the incision is made crosswise instead of longitudinal, for the purpose of avoiding cutting the cartilage. The puncture of this membrane may be sometimes made with advantage in instances of sudden asphyxia; a penknife or a common lancet the author has found to answer for its performance in case of need. Under other circumstances the operation has been abandoned, as the opening it affords is too small, when the object is to remove a foreign body, or insert a proper sized canula.

b. Section of the thyroid cartilage. (Thyrotomy.) (Pl. LV. fig. 7.)—This method was devised by Desault, and is particularly well suited for the removal of foreign bodies lodged in the larynx. It consists in splitting the thyroid cartilage by an incision in the middle line and separating the two halves so as to expose completely the ventricle of the larynx and the opening of the glottis, in which the foreign substances are frequently found impacted. The operation is easy of performance in consequence of the cartilage being superficial.

The incision is to be made in the middle line, from the os hyoides down to the upper margin of the cricoid cartilage through the skin and superficial fascia. The two sterno-hyoid muscles are next separated. The crico-thyroid artery may now be felt pulsating.

* Vide Guy's Hospital Reports.

ing as it crosses the crico-thyroid membrane. This vessel is to be pressed towards the cricoid cartilage with the nail of the left fore finger, and the operator then enters the point of a bistoury, with its back to the vessel, through the membrane above it. A probe-pointed bistoury is now introduced at the puncture, and run upwards in a slanting direction through the glottis, so as to divide the thyroid cartilage in the middle line up to the hyo-thyroid membrane. If the cartilage, as is frequently the case in the adult, be found hard and resisting, the incision may be aided by pressure with the thumb of the left hand against the back of the knife. In case the cartilage is completely ossified, it has been recommended to notch it in a linear direction with a saw, and complete the division with the knife in the manner above directed. The essential part of the operation is to keep the knife precisely in the middle line, so as to make the cut, without injuring the anterior attachments of the thyro-arytenoid muscles and the vocal chords. After the section, the two halves of the thyroid cartilage are to be held asunder with blunt hooks, so as to leave a lozenge-shaped space, at the bottom of which is the ventricle of the larynx. If the foreign body be fixed, it is to be seized with the forceps and withdrawn as shown at Plate LV. fig. 7, A, or, if found more convenient, pushed upwards into the pharynx. But if it is merely loosely held, or hidden by the turgescence of the membrane so as to require to be searched for, some precaution will be required, in case of its sudden dislodgment, to prevent its falling into the trachea. The end of the little finger will serve as the most fitting sound, and will answer, after the discovery of the body, as a director for a pair of forceps with which it may be removed. As soon as the object of the operation is effected, the wound—provided there is no other obstruction in the air passages—is to be closed with adhesive straps, for the purpose of uniting the parts by the first intention. It might possibly happen after the section of the cartilage, that the foreign body could not be detected; the same course is then to be pursued as directed in tracheotomy—to retain the wound open till the following day, and in case the body is not spontaneously dislodged, repeat the efforts for its removal. This operation is attended with little or no hemorrhage, and is mainly relied upon for the removal of substances lodged in the cavity of the larynx. The risk of injury to the vocal chords which has been urged against the method appears to be but slight, for in none of the many cases in which it has been practised, does the voice appear to have suffered any alteration.

c. Section above the hyoid bone, through the thyro-hyoid membrane.—This is a method proposed by M. Malgaigne, the value of which has not been tested by its application to the living subject. It consists in making a transverse section of the thyro-hyoid membrane and base of the epiglottis. A transverse incision an inch and a half to two inches long is to be made through the skin and superficial fascia, immediately below the inferior border of the os hyoides. A second incision is then made so as to divide the platysma and the inner half of the two sterno-hyoid muscles. The cutting edge of the bistoury is now directed backwards and upwards so as to divide—above the branch of the thyroid artery which crosses this space—the hyo-thyroid membrane and the fibres which come from the epiglottis. The mucous membrane, which will be forced into the wound at each expiration, is to be seized with a pair of forceps and divided with the bistoury or

scissors. The epiglottis is next to be drawn upwards with a blunt hook; the cavity of the larynx is then exposed so as to admit of the introduction of the finger or a pair of forceps, for the removal of any foreign substance lodged in it.

In case a fistulous orifice is left on the removal of the canula after tracheotomy, it is to be closed by a plastic operation—either by sliding a flap of skin over the orifice after it has been made raw, or by inserting the flap as a plug into the opening, and fastening it there with a hare-lip suture.

ŒSOPHAGUS.

The œsophagus is a long, muscular canal, flattened from before backwards, nearly an inch in diameter when moderately distended, but susceptible of much greater local dilatation. It is a continuation of the pharynx downwards; as it descends in the neck it inclines a little to the left of the middle line of the vertebral column, and keeps this inclination till it terminates in the cardiac orifice of the stomach, immediately after it has passed through its proper foramen in the diaphragm. In the upper third of its course it is immediately behind the trachea—in its lower two-thirds in front of the aorta. When its cervical portion is distended, as in the act of deglutition, the tube is opened by the advance of its anterior wall, which at the same time makes pressure against the yielding membranous structure at the posterior part of the trachea, so as to occasion, when its distension is unduly great, more or less sense of suffocation. At two portions of its course, the œsophagus may suffer a spasmodic narrowing, independent of any permanent or organic stricture; viz., its upper orifice, where it comes off from the pharynx immediately behind the cricoid cartilage—and at its gastric or cardiac orifice.

CATHETERISM OF THE ŒSOPHAGUS.

This operation is required for the fulfilment of various indications; the removal of foreign bodies—the dilatation of strictures—and for the purpose of throwing fluids into or the removing them from the stomach. The instruments employed in catheterism are introduced either by one of the nostrils or by the mouth.

Introduction by one of the nostrils.—This is to be resorted to when the catheter or stomach tube is to be left long in place, or there are cogent reasons against its introduction by the mouth. If intended to be carried into the stomach, it must be from two to two and a half feet in length. The patient is to be seated with the head thrown back; the tube, held like a pen, is then to be pressed slowly through the nostrils till it strikes against the posterior wall of the pharynx. If it does not turn of itself downwards in the direction of the pharyngeal passage, the surgeon introduces the fore finger of one hand through the mouth so as to give the point the proper direction, while with the other hand the introduction is continued through the nose. As the point approaches the larynx, care must be observed that it is directed well backwards, so as not to enter the glottis, which accident, if it take place, would be made known by a sense of suffocation, cough, and the passing of air through the tube. As the instrument in its descent reaches the upper orifice of the œsophagus, it will encounter resistance from the spasmodic contraction of the muscular fibres of the part.

The surgeon should then pause for a moment, until the spasm subsides, when the instrument may be passed with a gentle effort, and readily carried on into the stomach. The operator should use the precaution to introduce it slowly forwards, relaxing the pressure when any resistance is manifested, and if this does not speedily subside, retract the instrument slightly and pass it on again with its direction a little varied, or with a slight rotatory motion given by a twist between the thumb and finger.

Introduction by the mouth.—The mouth is to be widely opened. The surgeon passes his left fore finger down to the epiglottis, so as to depress the tongue. This finger will then serve as a conductor to the sound or catheter, which, when passed over its dorsal surface, will be found slipping readily into the pharyngeal passage, from whence it is to be carried downwards according to the directions above given. The introduction of instruments by the mouth is much more easy than by the nostril, and is, as a general process, decidedly the most appropriate. It is the only one which admits of the passing of metallic or wax bougies for the dilatation of strictures of the œsophagus, or the gula forceps, hooks, or probangs for the removal of foreign bodies. If the employment of the stomach tube be rendered necessary by a wound which has involved the lower portion of the pharynx or the upper part of the œsophagus, the point of the instrument is apt to hitch against the lower segment of the cut. Under these circumstances I have found it necessary to support the lower lip of the divided gullet with a pair of forceps while the tube was passed by. When fairly introduced into the stomach, it is very easy with the stomach pump, or even with an ordinary syringe of large size, the nozzle of which should fit well in the free end of the tube, to draw out by suction the contents of the stomach, and wash the organ free of noxious materials by the alternate injection and withdrawal of warm water or some appropriate aqueous solution. If the object of the catheterism is to supply the patient with nourishment, this is to be thrown in in nearly a similar manner, by gentle injection with the syringe. Under many circumstances, as that of a wound or stricture at the upper part of the passage, it will be unnecessary to have the tube of a greater length than fairly to pass by the affected part; and this shortening of it is especially desirable when the tube is to be kept for some time in the passage, as it might otherwise irritate the delicate lining membrane at the cardiac orifice of the stomach.

Stricture of the Œsophagus.

Catheterism for the purpose of dilatation or the application of caustics, is resorted to for the cure of this affection.

Dilatation.—Elastic or wax bougies and catheters have been employed for the cure of strictures of the œsophagus, upon the same principles as for those of the urethra. Various complicated instruments have been devised for the same purpose, as the air dilator of Arnott, and the three-branched metallic dilator of Mr. Fletcher, but the use of the simpler instruments above mentioned has been found in general the most advantageous. In cases of simple muscular narrowing of the passage, the employment of the œsophagus bougie or catheter, introduced by the mouth, will commonly afford relief. In an elderly lady, Mrs. W., residing at No. 309 Walnut street, who had been for many years affected with a gradually increasing difficulty in swallowing, supposed to

be owing to paralysis of the muscles of deglutition, I succeeded by a single insertion of the wax bougie in effecting the most decided relief. The narrowness was found at the pharyngeal orifice of the œsophagus, and was so extreme, that none but minute particles of food or fluid in spoonful doses could be passed into the stomach; frequently after the conclusion of a meal, the food would be found to have lodged above the stricture, occasioning so much inconvenience as to cause the patient to dislodge it by the insertion of a finger into the throat. The bougie encountered considerable resistance at the strictured point; in a few minutes after the removal of the instrument, the patient to her surprise was enabled to drink off a tumbler of flaxseed tea with entire freedom, and on the same day took her meals without apparent inconvenience.

More usually, however, even in strictures of this description, it will be found necessary to repeat frequently the use of the bougie before the obstruction is overcome. Unfortunately, simple muscular narrowing forms but a small proportion of the cases of œsophageal stricture. In most instances, the constriction of the passage will be found the result either of tumours that press upon the outer wall of the œsophagus, or of some degeneration of its inner structure, susceptible only of temporary alleviation from the use of dilating instruments, which, under such circumstances, must be used with great caution for fear of causing a rupture of the tube, which, as stated by Sir C. Bell, has occasionally taken place.

Cauterization.—From the experience of Paletti, Home, Sir C. Bell and Mr. Macilwain, it would appear that the application of lunar caustic might be made with advantage to those forms of stricture of the œsophagus, dependent upon induration from chronic inflammation. In strictures the consequence of degeneration, the use of the caustic could, however, rarely fail to be injurious; and in the former class of cases, the employment of the bougie would furnish a fair prospect of relief. From the difficulty of diagnosis, and for the reasons above stated, the cauterizing practice has been received with but little favour. Paletti cauterized the passage with a roll of linen steeped in a caustic solution, and introduced on the end of a flexible whalebone stalk, like that of the ordinary probang. A small piece of the solid lunar caustic inserted into the end of the common œsophagus wax bougie, in the manner of Sir E. Home, is considered the most appropriate method of cauterization.

Removal of foreign bodies from the Œsophagus.

Foreign bodies of various description may be lodged in the œsophagus. The symptoms to which they give rise, and the indications for treatment, will vary according to their nature. There are three methods for their removal by manipulation through the œsophagus.—Propulsion into the stomach, extraction by the introduction of instruments through the mouth, and a third, which consists of an incision into the œsophagus (œsophagotomy).

Propulsion.—When the obstruction consists in the lodgment of an alimentary substance, arrested in consequence of its forming a bolus of too large size, or from the deficiency of the proper lubricating secretions of the passage, or in consequence of a temporary spasm of the circular fibres, the operator, unless the necessity for relief is urgent, should defer for some hours any decisive course of action, inasmuch as the substance, from its digestibility,

becomes softened on its surface so as ultimately to be driven into the stomach by the proper muscular contraction of the tube. In temporary obstruction of this sort, slight taps upon the back and the ingestion of mucilaginous or oily liquids will often be found useful in facilitating its removal; or, these failing, an attempt may be made to dislodge the impacted mass by exciting efforts at vomiting either by tickling the throat, or gargling with an emetic solution. As a final resort, the operator may force it inward to the stomach by the use of a probang, an instrument which consists of a flexible strip of whalebone, with a piece of sponge or a roll of linen securely attached to it as a head. In some instances, when the alimentary substance is not deeply lodged, it may answer better to remove it by the following process.

Extraction.—If the body is of an indigestible or irritating nature, as a piece of wood, coin, pin, etc., an effort should be made to extract it through the opening of the mouth and pharynx. If it be lodged in the pharynx, or at the upper orifice of the œsophagus, it may be readily removed with the fingers or a pair of curved gula forceps.

If the foreign body be more deeply lodged in the œsophagus, its removal will be found more difficult. Various instruments are under such circumstances employed. One of those commonly used, consists of the probang, with the sponge-head elongated, and passed down without being previously imbued with fluid, with the hope of getting it below the foreign substance; if successful in this attempt, it is to be allowed to rest for a few moments till the sponge becomes expanded by soaking up the secretions of the part, and then retracted so as to bring with it the foreign body. The difficulty of getting this instrument past the impacted substance is such that it will be found more likely to propel the substance forwards towards the stomach. Various other contrivances have been attached to the whalebone stalk; a silk bag, a movable blunt hook, loops made of bent silver or brass wire, or bristles or thread or narrow ribbon. A long single or double wire, smoothly bent into the form of a hook at the entering end, occasionally answers a good purpose, and especially for the extraction of a piece of coin. With instruments of this description, extraction may sometimes be effected, but in general greater success will attend the use of such as are calculated to grasp the substance. The best of these, even when the body is deeply lodged in the œsophagus, is the long-branched gula forceps, devised by Dr. Henry Bond, of this city, and described in the North American Medical and Surgical Journal for 1828. The peculiar advantage of this instrument consists in the long narrow curved blades meeting by convex surfaces, serrated on the middle line so as to be incapable of doing injury to the walls of the tube, while they lay firm hold of any substance over which the opened blades can be slid, and allow it, in case it be an oblong body like a pin, to revolve so as to present its long axis parallel with that of the tube. Other instruments have been invented for the same object,—such, for instance, as a tube with a stilet moving in the centre, and made either to throw out over the substance to be removed a three-branched forceps like the lithotritic forceps of Civiale, or to pass below it, and spread out its branches like the inverted ribs of a parasol; but the author has met with none equal to the forceps of Dr. Bond in regard to simplicity of construction or convenience for general use.

ŒSOPHAGOTOMY.

This operation, which fortunately is one that is but rarely required, may be performed for the fulfilment of two indications—the removal of a foreign body that cannot otherwise be dislodged, or for the opening of a passage for the introduction of alimentary substances in the stomach, with the object of prolonging life in cases of complete obstruction of the pharyngeal orifice of the œsophagus.

The operation is directed to be performed on the left side of the neck, as the tube is there most accessible; though in cases of necessity, arising from any peculiar morbid condition of that side, it may be accomplished upon the right. The incision should be made, as directed by Boyer, between the sterno-cleido-mastoid, and the outer edge of the bundle formed by the sterno-hyoid and thyroid muscles. If a foreign body is lodged in the œsophagus, the tumour it forms will serve as a guide to direct the course of the incision; but even in case a tumour can be felt, and more especially when the operation is performed for organic stricture, it is important to introduce an œsophagus sound or bougie by the mouth, so as to project the side of the œsophagus, and render its position obvious to the surgeon. In the removal of foreign bodies, many surgeons employ a hollow canula, with a dart stilet that can be forced from the interior through the wall of the œsophagus after the external incision has been made. Vacca Berlinghieri devised an instrument for the purpose, in which the dart stilet was grooved upon one side so as to direct the point of the bistoury in the incision of the tube, in the manner in which it follows the grooved staff in the cut for stone.

Operation.—The patient is to be placed semi-recumbent on a narrow bed, with the head reversed toward the right side. The operator stands upon the left of the patient. An incision two and a half to three inches long is then made through the skin and superficial fascia along the groove between the sterno-cleido-mastoid and the sterno-thyroid muscles, commencing two fingers breadth above the sternum. The deep layer of fascia between these muscles is to be opened on the grooved director, and the muscles themselves separated with the end of the director, the finger, or the handle of the scalpel. To facilitate this operation, the surgeon depresses with his left hand the edge of the sterno-mastoid, and an assistant placed at the right draws gently in that direction the whole mass of the larynx and trachea, including the inner border of the wound. The omo-hyoid muscle now comes into view, and must be drawn backwards out of the way or divided across on the director. The cellular tissue is to be further separated till we get to the bottom of the groove, at the outer side of which will be found the sheath including the carotid artery, the jugular vein and the par vagum nerve, which, as well as the sterno-mastoid, the surgeon is to press outwards with his left hand. At the inner margin of the wound, the edge of the trachea and the thyroid gland may now be seen, and below these is the œsophagus, recognizable by the rounded prominence it forms, its muscular aspect, and the contraction into which it is thrown when the patient makes an effort at deglutition. If distended by a foreign body, or protruded by a sound passed from the mouth, the œsophageal tumour will now project into the cavity of the incision. If the sound has been introduced, the puncture is to be made over its end; if the sound with the dart stilet, this

is now to be forced through the wall, and the tube opened by its side. In case no sound has been employed, the puncture may be made at once over the rounded prominence of the tumour. A discharge of mucus following the puncture shows that the cavity of the tube is opened. The wound may then be extended downward with the scissors or a probe-pointed bistoury, to a sufficient extent to allow of the introduction of a finger or a pair of forceps for the extraction of the foreign body.

Dressing.—The lips of the incision are to be gently approximated, and merely covered with simple dressings. No sutures or adhesive straps are to be immediately applied, on account of the deep-seated suppuration liable to follow, as well as from the fear of ulceration or gangrene which may ensue when the tube has suffered severely from the long-continued distension to which it has been subjected. In the course of a day or two, if there is no counter-indication, the wound may be completely closed with adhesive straps or sutures. The stomach tube is to be inserted, to prevent the escape of any alimentary matter or drinks by the orifice of the wound, and should be kept in place for five or six days, or until union has had time to take place in the line of incision, in order to diminish the risk of an œsophageal fistula.

VI. OPERATIONS UPON THE THORAX.

The special operations described upon this region consist of those for the removal of the Mammary Gland, and of those for effusions into the cavities of the Pleura and Pericardium.

EXTIRPATION OF THE MAMMARY GLAND. (PL. LVI. FIG. 12.)

The removal of the breast is at times considered necessary in several benign or non-malignant affections, as well as those which are of a scirrhus or encephaloid character. In regard to the former class, extirpation with the knife is only to be resorted to after every judicious effort by general and local treatment has been found unavailing for their removal. In respect to the class of malignant affections of the breast, which of all others has been the most frequent cause of this operation, there has always been, from the period of Celsus to the present moment, great discordancy of opinions as to the propriety of its performance. The experience of intelligent surgeons of the present day is so directly adverse in relation to this operation, that it is impossible to reconcile their statements, except upon the supposition that all have not been equally careful in the rejection of such cases as the better informed of all practitioners now consider to counter-indicate the operation. Though the sweeping assertion of Monro, Delpèch and others, that local cancer is a mere symptom of a general cancerous diathesis, is considered in the main untrue, every experienced practitioner must be constrained to admit, that many instances do occur in which the local and general affection can scarcely be separated in point of time, and that in many others, the system so soon becomes contaminated after the manifestation of a local cancer, as to leave but little chance for the thorough extirpation of the evil. On the other hand, it is equally well ascertained,

that cancer of the breast as well as other portions of the body, does arise from purely local causes, and exists for months or years, or even (as in the form of horny or ligneous scirrhus, several times noticed by the author, though such cases must be considered rare), during the greater part of a long life without impairing the condition of the internal viscera, or developing the peculiar straw-colour of the complexion pathognomonic of the cancerous diathesis. Instances of exception, such as noticed above, have been arrayed as an argument against extirpation, especially of cancers in this region; but the argument is not one of much force, inasmuch as complete success is sometimes known to attend the operation, and it would be difficult to show that in the very cases alluded to, a similar favourable result would not have followed the use of the knife, and the operation for their removal upon the whole been a more judicious course than leaving the patient more or less exposed for years together to the risk of a constitutional affection.

There is no question, however, that the indiscriminate amputation of cancerous mammaræ, at all ages of life and in all their various stages of development, would be a most nefarious rule of practice, and that it would be far better for such as do not judiciously select such cases only as offer a fair chance of recovery after extirpation, to trust altogether to the influence of therapeutic remedies. The limits of this work forbid a full discussion of this most important subject, and it must suffice to state the general fact, which no one will gainsay, that perfect recovery occasionally takes place after the removal of a cancerous breast, but that in the greater number of cases a return of the disease is to be expected, either at the site of the cicatrix, or upon some of the internal viscera. The operation will consequently in many instances of local affection be justifiable, as it is easily and quickly practised, and but little painful. The essential principle in reference to its success, is to remove the cancerous breast, while it yet forms a well-circumscribed and local tumour. If it has involved the chain of axillary glands, and especially if it has become adherent to the pectoral muscle, or has formed an open ulcer, the chances of success, even when there is a prospect of removing apparently all the tissue affected, will be considerably impaired, and the operation ought not to be undertaken without a candid statement on the part of the surgeon of the liability of the patient to suffer sooner or later a return of the affection.

Operations, however, done even under these circumstances by the author's surgical friends, and by himself, have in some instances been entirely successful, and in other cases, served so far as all human reason could show to diminish suffering and prolong life. But when the disease has involved the substance of the pectoral muscle, or the rib, or a large portion of the integument, or the tissues at the top of the axilla, and especially if there be reason, from cough and from physical examination, to suppose that the organs of the chest are involved, or when the straw-colour of the skin, and other general signs of the cancerous cachexia are apparent, the operation should be altogether proscribed. It may indeed be stated as a general proposition, that it is only when the scirrhus of the breast forms a movable tumour, which under all rational therapeutic methods of treatment continues to advance and threatens to involve the general system, that it can with perfect propriety be removed by an operation.

The destruction of cancerous tumours of the breast with caustics, and even with the paste of the chloride of zinc—an article for a time so much lauded in these cases—as well as the attempt to remove them by systematic compression, as practised by Young and Récamier, have in general been abandoned, as they were found to present no advantages over the removal with the knife: the treatment required being necessarily protracted, infinitely more painful, just as liable to be followed by a return of the disease, and without the same certainty of arresting the direct progress of the affection.

Operation.—The patient may be seated on a chair, or laid upon a bed, supported by an inclined plane made of pillows, so as to keep the head and chest elevated. The arm of the diseased side is to be raised and rotated outwards to render the pectoralis major muscle tense; the face should be turned towards the opposite shoulder. The operator sits or stands upon that side of the patient upon which the operation is to be performed. An assistant supports the head of the patient, and may make pressure with his thumb upon the subclavian artery between the scaleni. With the other hand he may, if he is adroit, compress the arterial branches divided during the operation, provided the pressure on the subclavian should not suffice to completely check the flow of blood; or another assistant may be placed at hand for the latter object, unless the operator should prefer, as is the practice of Dr. Jacob Randolph—a most judicious surgeon of this city—to pause and tie the vessels as they are divided, with the double object of diminishing the waste of blood, and avoiding the risk of secondary hemorrhage, which sometimes arises from the retraction of the vessels and the inability to find them at the conclusion of the operation, when they have temporarily ceased to bleed.

The form of cutaneous incision has been much varied—between the crucial, the T, the vertical, and the elliptic. The last

however, is the only one usually found appropriate, as it enables us to remove at the first step such portions of the integuments as appear diseased, or would be found too redundant to close neatly over the wound after the removal of the tumour. The long axis of the ellipse should be directed from below outwards and upwards towards the armpit, as this corresponds with the longer diameter of the gland and the lower border of the pectoral muscle, and enables the operator to extend the opening by a linear incision into the axilla over the course of the absorbent vessels, when it is desirable to remove the enlarged glands of that region. Having properly placed his assistants, the surgeon now raises the breast with his left hand so as to extend the skin below the tumour, and makes, from above downwards on the right side, and from below upwards on the left, a semi-elliptical incision beneath the nipple, concave upwards. Then reversing the breast, he makes another similar cut, concave in the opposite direction, and continuous by an acute angle with the two extremities of the first. The space thus circumscribed should include the nipple, extend beyond the limits of the diseased integument, and even when this is healthy, embrace as large a portion as would be requisite to allow the lips of the wound to fall neatly together after the removal of the tumour. The surgeon now dissects off the integuments at the lower edge of the gland, then raises the tumour with his left hand and detaches it from below upwards at the line of the lower incision, to avoid the embarrassment from the flow of blood which would necessarily attend the dissection in the upper line of incision. The dissection should be made rapidly and by long sweeps, in the direction of the fibres of the pectoral muscle, with the bistoury in the sixth position, and the edge kept well inclined upon the healthy tissues, of which it is all important to remove a part, so as to be certain of getting beyond the limits of the affected structure. If the tumour is of medium size, it may be

PLATE LVI.—EXTIRPATION OF THE MAMMARY GLAND.

Fig. 1.—The patient is to be placed semi-recumbent, with the head and shoulders raised, (or if it be preferred merely seated on a chair,) with the arm raised and abducted. An assistant presses with the thumb of one hand (*a*) upon the subclavian, and with the thumb and fingers of the other (*b*) closes the orifices of the vessels opened during the operation. An elliptical incision has been made through the integuments, and the tumour, which has been dissected loose from over the pectoral muscle—first at its lower margin and then at its upper—is, at the period of the operation shown, raised with the left hand of the surgeon (*c*), and on the point of being removed with the knife in his right (*d*).

Fig. 2.—This is a drawing taken at one of the operations of the author during the publication of this work. The patient is seated in a chair. The chain of axillary glands being enlarged and scirrhus, were removed with the tumour. An elliptical incision was made as in *fig. 1*, with the exception that the upper line of incision was carried along the lower border of the pectoral tendon into the hollow of the arm pit. The breast (*a*) has been dissected loose, and used as a sort of handle to draw down the chain of glands (*b*) connected by the bundle of absorbents and some cellular tissue to its outer margin. After the cautious isolation of the glands a ligature has been thrown round the pedicle (*c*) formed by the cellular tissue and vessels, and the knife applied below the ligature for the purpose of detaching the diseased mass. A blunt hook has been employed by an assistant for the purpose of raising the integuments over the tendon of the pectoral muscle.

Fig. 3.—Dressing of the wound after the operation in *fig. 2.*—The tails of the ligatures with which the arteries have been tied are drawn out at the lower and inner margin of the wound, as well as the end of a mesh introduced between the edges of the wound at the lower end of the incision, for the purpose of allowing a free exit to the fluids of secretion. These are confined in place by a short adhesive strap. Five adhesive straps are placed diagonally across the chest, to approximate the lips of the incision.

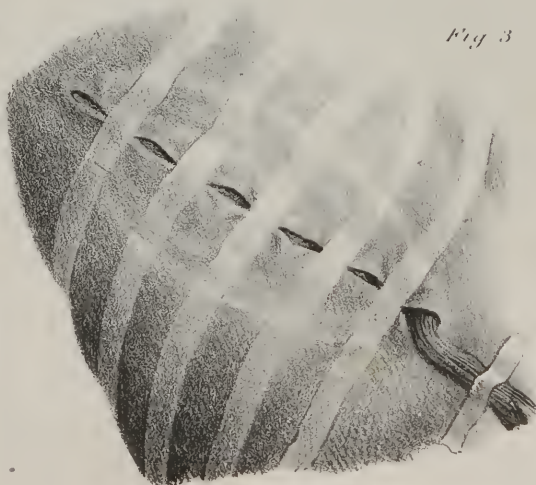
Fig 1



Fig 2.



Fig 3



entirely detached in this manner from below upwards, especially if the patient be semi-recumbent on a bed. But if it be of large size, it is best to loosen it as far as convenient from below, and finish by dissection at the upper line of incision. As the vessels spring, their orifices are either to be closed by the fingers of an assistant, or tied. A second assistant clears away the blood as it escapes behind the track of the bistoury, for the purpose of exposing the jetting orifices of the vessels, and keeping the surface for incision clearly in view. As soon as the tumour is removed, and the bleeding orifices of the vessels secured, the surgeon proceeds to make a careful examination in order to ascertain if there be any diseased or suspiciously affected structure remaining in the surrounding cellular tissue or muscles; and if any such be found, he carefully dissects it away. If one or two of the ribs should, after the operation was begun, unfortunately be found involved in the disease, the affected portions are to be resected with the cutting forceps or a Hey's saw. If one of the edges of the rib be but superficially diseased, it has been advised to touch it merely with the heated iron.

Removal of the axillary glands. (Pl. LVI. fig. 2.)—Such of the axillary glands as are supposed to be scirrhus, or are even indurated and enlarged, should be taken away. These are found in the two directions in which the thoracic absorbents run to the glands—at the top of the armpit on the outer surface of the serratus major anticus muscle, and under the edge of the pectoralis minor. They are separated from the axillary vessels and the brachial plexus of nerves only by the aponeurosis and a mass of cellular tissue which is usually found more or less diseased; are supplied by one of the external thoracic arteries, and require considerable caution in their removal. A second operation, as it were, is required for this purpose. It has been advised to detach the breast completely, and then make a new incision in the axilla over the chain of glands. But no surgeon who has extirpated these glands would forego the advantage of preserving them in their rope-like connection with the outer end of the breast, for this organ, when once detached, can be made to serve as a handle to draw them downwards, make them more superficial, and widen the space which separates them from the axillary vessels. When the glands are to be removed, the operator should therefore be careful to preserve their connection with the tumour of the breast. As soon as this is loosened so as to be raised from its bed, the surgeon makes a linear incision into the axilla from the upper angle of the wound along the edge of the pectoral tendon, as shown in fig. 2; the arm being raised as far as possible, and rotated outwards so as to carry up the vessels of the axilla and render the fossa superficial. The skin over the tendon of the pectoralis major is to be raised with the blunt hook, and the tendon itself may, as directed by Mr. Fergusson, be partially divided with the knife if found to obstruct the dissection for the detachment of the glands. I have never, however, found this step necessary, though it might be needed, especially if any of the glands were enlarged under the edge of the pectoralis minor, or an attempt was made to dissect away the lower axillary chain, without observing the precaution to keep them in connection with the loosened mammary tumour. The chain of glands must be separated from their connection as far as possible with the finger or the handle of the knife, using the point of the knife with cau-

tion to detach here and there some more resisting cellular bands. When the uppermost affected gland is loosened, care should be taken, in order to avoid hemorrhage from the vessels, (which, when divided, would retract so as to be difficult to discover,) to apply a ligature, as shown in the drawing, just above the point at which the final separation of the diseased structure is made with the knife.

Dressing. (Fig. 3.)—This ordinarily is very simple. The tails of the ligatures are to be brought out at the lower angle of the wound along with the end of a small greased compress, which should be inserted for the purpose of favouring the exit of such fluids as may form in the hollow of the wound. The blood is to be carefully cleansed away with the sponge, and the lips of the incision approximated with five or six strips of adhesive plaster. Lint spread with cerate, and a soft thick compress, are to be laid over the wound, and the whole secured to the chest by a roller applied with moderate tightness, and kept from slipping by a few turns over the shoulder. If the skin prove a little too redundant, so as to pucker when flattened out under the use of the straps, the lips of the wound may be adjusted with a few sutures in place of the straps. In case the skin, in consequence of its being diseased, has been removed to such an extent as to leave a gap in the dressing, it has been directed by Lisfranc to dissect it up further back, till the flaps by stretching may be made to meet under the use of the adhesive straps. The plan of M. Martinet, which consists in dissecting up a flap of skin from the neighbouring parts, and turning it in at once so as to fill up the gap, as in one of the plastic processes, is considered preferable to the proposition of Lisfranc. If, after the removal of the glands, there should, as sometimes but not always happens, be œdema of the corresponding extremity, it will be necessary to make friction with a mild liniment, and apply a roller upwards from the hand.

EMPHYEMA.

This term is varied from its proper etymological signification, and applied to every collection of fluid—air, water, pus, or blood—in the cavity of the chest, which, in defiance of all remedial applications, continues stationary or increases in bulk. The most common perhaps of these, that which is most fatal usually in its issue, and which the term empyema more properly implies, is an effusion of purulent fluid. This may take place into the pleural cavity from several sources, and the lungs from their yielding nature, offer but little resistance to its accumulation. It may be derived either from sources remote from the cavity or from the surface of its lining membrane. Abscesses of the mediastinum, vomicae of the lungs, or phlegmonous abscesses of the lungs or liver may gradually, by perforating the tissues which separate them from the pleural cavity, discharge their contents into this space, a result particularly liable to take place from the tendency to a vacuum produced in the thorax during the act of inspiration. In chronic or subacute inflammations of the pleura, either commencing in a latent form in subjects where the sympathies are so obtuse as not to reveal it in its early stages to the patient or his attendant—or in acute inflammations, which, ceasing to excite pain or to disturb greatly the action of the organs, instead of disappearing entirely, have subsided into the chronic form—the serous

membrane of the thorax may be so perverted as to perform the office of a mucous lining, and discharge gradatim a purulent fluid for which there is no natural outlet. The deposition of the secretion, considered in itself, though exhausting to the economy, is never directly fatal. But in the end the fluid, if it accumulates in great quantity, will occasion distress from its gravitation upon the diaphragm, may produce hectic symptoms, displace the heart and the lungs, and thus embarrass the two most vital functions, those of circulation and respiration. In contemplating the chances of recovery from this disease, everything will appear to depend upon the origin of the inflammation which gives rise to the secretion—whether it is an idiopathic affection of the pleura, or whether it is secondarily induced by a neighbouring disease in the lungs or liver. Even under the most favourable circumstances, when the cause of the disease is found in the pleura, the event must necessarily sooner or later be fatal, unless the matter is discharged by spontaneous ulceration through the walls of the chest, or the surgeon takes measures to procure its evacuation.

Surgical and pathological anatomy.—In the healthy state of the thoracic viscera, the lungs are always more or less filled with air, are in complete contact with the walls of each pleural sac, and descend at their lower and outer edge to within two or two and a half inches of the lower border of the thorax formed by the inferior ribs. The diaphragm, which gets its proper muscular attachment from the cartilaginous border of the thorax, is nevertheless, as it is reflected upwards, adherent by cellular tissue to the inner face of the ribs as far as the line to which the lower and outer edge of the lung descends. Thus, though there is in the healthy state no space between the angle formed by the ascending surface of the diaphragm and the thoracic walls, and the margin of the lung, one will be found to exist when the diaphragm is depressed at its place of attachment to the ribs, by an accumulation of fluid in the cavity of the chest. If the effusion take place to much amount, the fluid makes room for itself by a gradual compression of the lung of the same side towards its root; in some extreme cases, effacing by this means the areolar structure of the lung, filling completely the cavity of the chest, and pushing the heart and mediastinum off in the direction of the other pleural cavity. Until the cavity of the chest becomes fully distended, the upper line of the fluid will be found, in obedience to the laws of gravitation, (unless it be confined, as it were, in cysts, by adhesion between the adjoining surfaces of the costal and pulmonary pleuræ, or by layers of false membranes,) transverse to the chest in the upright, and vertical in the recumbent posture of the patient. Not unfrequently the inner surface of the pleura will be found in these cases covered by a thick laminar effusion of false membrane. As soon as the compression of the effused fluid becomes so great as to suspend the action of the lung, the thoracic cavity itself becomes expanded; this is called effusion with dilatation.

From the improved means of diagnosis now possessed in reference to these affections, we are able to determine with very considerable precision, the causes, the seat, as well as the exact limits of every pleuritic effusion. It is only after the careful employment of these measures, that the surgeon is to determine as to the propriety of an operation, or the appropriate place for its performance. If the effusion is encysted, as it may be in any part of the walls of the chest, or there is an external pointing or protrusion

accompanied with cutaneous inflammation, the point for the operation is fixed, and is then called *the place of necessity*. But when the effusion is not thus restricted, the *place of election* for the puncture is at the will of the surgeon. Of the operation at the latter place, it will be necessary further to treat.

Place of election.—What part of the chest should be selected for the puncture, has been a point of much controversy among surgeons. Almost any portion of the side between the fourth and eleventh intercostal spaces may be made to answer, but the governing rule should be to select that at which there is the most unequivocal evidence of the existence of the effusion. The older surgeons were in the habit, from the peculiar arrangements of the external muscles, of selecting the space between the fifth and sixth or sixth and seventh ribs, on the antero-lateral aspect of the chest, where the digitations of the serratus major anticus and the external oblique muscles meet, as there is here the smallest amount of tissues to divide, and the fluid may readily be discharged by the puncture, provided the patient be inclined upon the side. But this reasoning is of little moment, inasmuch as the thickness of the walls is in no part great, and more advantage will be derived from a puncture at a depending part of the distended cavity, from the readier outlet afforded to the fluid in all positions of the trunk.

French surgeons in general, and the experience of the author leads him wholly to coincide with their views, direct the puncture to be made in either the eighth or ninth intercostal spaces on the right side, or the tenth or eleventh on the left. The desired place for puncture is usually readily determined by counting the spaces from below upwards. But in case this should be rendered difficult, from the obesity of the subject, or from extensive œdema, it will answer to enter the trocar at a point five fingers' breadth below the inferior angle of the scapula, or three fingers' breadth above the cartilaginous border of the thorax, and as nearly as may be at the junction of the posterior third with the anterior two-thirds of the walls of the cavity—in front of the latissimus dorsi.

Modes of operation.

There are two modes of performing the operation—incision with the bistoury, or puncture with a trocar. It may moreover be observed that in cases where the empyema has shown a disposition to point, it has been opened with a lancet like any other abscess, the only peculiar precaution requisite being that of preventing the introduction of air during the act of inspiration.

1. *Incision.* (*Usual process.*)—The patient is to be seated or partly reclined on the sound side, and the arm elevated in order to make the soft part tense over the side of the chest. The surgeon stretches the skin between the thumb and first two fingers of the left hand, and makes an incision an inch and a half long over the edge of the rib, which is immediately below the space that he intends to open. He then raises the upper lip of the incision, and divides in succession, just above the edge of the rib, the layers of muscles as they come in view, feeling with the left fore finger whether there be any artery in the way that it is necessary to avoid. As soon as the pleura is exposed, the patient should be directed to make a full inspiration; this usually causes the pleura to bulge between the lips of the wound, so as to render it more readily punctured with the knife, which should be directed obliquely upwards and inwards. If distinct fluctuation is still felt

with the finger, and the pleura does not protrude, it is owing to its being thickened by layers of false membrane on its inner surface; the use of the knife may still be cautiously continued, and the layers, if they are thick, finally opened by pressure obliquely upwards with the end of the finger or the handle of the scalpel. If in this way we do not readily reach the cavity of the abscess, the lung is in all probability adherent to the costal pleura at this place, and it becomes necessary for the operator to close the wound and make a puncture at another point. An error of this description with the improved means of diagnosis we now possess, is, however, readily avoided. When the opening is made, the fluid is to be allowed gradually to discharge itself, unless the patient becomes faint from the sudden relaxation of pressure, when the finger or a compress may be temporarily applied upon the orifice. If the flow is interrupted by flocculent masses of lymph or grumous blood, the passage may be cleared with a probe. At the conclusion of the operation it has been advised to carry a mesh of linen or charpie into the wound, to serve as a conductor for the escape of the remaining fluid or such as may subsequently form. If the re-accumulation occurs rapidly, it is necessary to separate the lips of the wound again in the course of a few days, to allow the free evacuation of the fluid. Some surgeons have directed the orifice in the pleura to be made of large size; but this, as well as the introduction of the mesh, is by most judicious surgeons considered hazardous, since the entry of air into the cavity of the chest, which it would almost necessarily involve, would in all probability prove injurious, especially in purulent or sanguineous effusions.

After the operation, the general state of the patient and the character of the fluid discharged, must be carefully observed. If the respiration becomes more free, and the pus, in the course of a few days, is found of thicker consistence, free of odour, and at the same time less abundant, there is a fair prospect of a cure. But if, on the other hand, the discharge becomes thinner, more abundant, and more fetid, and the constitutional symptoms are more strongly marked, the prognosis is unfavourable. In the latter case, in which there is reason to fear that the vitiated secretion may be taken up by the absorbents, it has been recommended by MM. Billeret and Récamier to resort to the ancient practice of washing out the cavity with injections of warm water or mucilaginous or astringent solutions. In all cases in which the mesh is inserted, it is necessary to wait till all the tendency to the formation of fluid ceases, before the wound is allowed to close.

Such is the process commonly advised for paracentesis of the chest, whatever be the nature of the fluid collected. In regard to the success attending it, there are among different writers the most discordant statements—a certain evidence that in by far the greater number of cases the prognosis must be unfavourable. Some practitioners prefer to this continued discharge through an orifice kept open for the purpose, the evacuation of the fluid by successive operations, allowing the orifice to close after each puncture, as is the ordinary practice in ascites. But this method is considered objectionable, as it requires frequent repetition, in consequence of the unyielding nature of the thoracic walls and the slowness on the part of the lungs to re-expand when they have been held for a long time in a state of compression.

Process of the author.—The author has been led to adopt the

following modification of the process above described, as one guarding more certainly against the entry of air into the thoracic cavity, and enabling the operator for any requisite length of time to maintain a daily evacuation of the fluid without a constant offensive discharge over the side of the chest. A case treated with perfect success by this process will be found described by the author in the *Am. Journ. of Med. Sci.* for 1833. It consists first in making, near the lower boundary of the distended cavity, a valvular opening for the outlet of the fluids, which was so much insisted on by the ancient surgeons. The skin is to be well drawn upwards from below, and the integuments incised over the middle of the rib below the intended place for puncture. The divided edge is now to be further raised with a blunt hook so as to expose the intercostal space above. After the division of the outer layer of muscles and the first range of intercostals, the fluctuation of the fluid can usually be distinctly perceived; a good-sized trocar is then to be pushed into the cavity of the chest obliquely upwards, so as to avoid all risk of injury to the diaphragm. After the evacuation of the fluid the flap of integuments will be found to form a valvular fold, extending from an inch and a half to two inches below the opening into the pleural cavity. The wound is to be dressed with a compress and bandage. A slight leakage of fluid from the chest prevents union by first intention, or at least so far retards it that on the following day a female silver catheter may be insinuated under the valvular fold of skin into the cavity, so as to let off a portion of the re-accumulated fluid. By employing the catheter in this way, at first daily and then at longer intervals, the track is kept fistulous, and yet retains so completely its valvular properties, that in inspiration it will be found when uncovered to sink in over the place of puncture, without allowing a particle of air to enter the chest. By this means a frequent discharge of the secreted fluids is kept up, and the lung is placed under the best circumstances for its gradual dilatation. In the course of a few weeks the patient is able to draw off the fluid by the use of a gum elastic catheter, which should be carried along the passage without a stilet. In purulent effusions it may be necessary in this way to keep the orifice open for many months, before the discharge ceases, or the cavity previously formed, becomes effaced by the gradual expansion of the lung, the rising of the diaphragm, and the sinking in of the ribs, the principal means by which this change is effected.

2. *By puncture.*—Velpeau has proposed to evacuate the fluid by a direct plunge with the bistoury through one of the intercostal spaces, nearly as in opening an ordinary abscess. This would in many cases be necessarily attended with some risk of injury to the lung, whether it be free or adherent, and is considered an objectionable proposition.

With the trocar. (*Usual process.*)—The integuments are to be drawn strongly upwards with the left hand, and the trocar pushed in obliquely upwards immediately over the upper edge of one of the ribs. In ordinary cases, even with this oblique direction of it, the trocar, when buried to the extent of an inch, is found to have entered the cavity. The length of the route may, however, be increased by the obesity of the subject, by the infiltration of air or water under the skin, or from the existence of layers of false membrane upon the pleura. If, after making the necessary allowance for these occurrences, the point of the trocar is not found to move

freely as it ordinarily does when it has entered a cavity, the instrument, if pushed on farther, should, in order to diminish the risk of wounding the lung, be turned still more directly towards the point, which, from the physical examination of the chest, is considered the centre of the accumulation. If, however, after proceeding cautiously in this way, the surgeon does not speedily strike the cavity, in consequence of the lung being found adherent at this point to the ribs, it will be more prudent for him to retract his instrument and repeat the puncture at another part of the chest. After the evacuation of the liquid, the canula—slightly retracted and with a plug in its outer orifice—is directed to be left in the wound for the purpose of repeating the process of evacuation.

M. Baudens employs a curved canula, with two stilets;—one sharp-pointed, for the purpose of introducing the canula; and another, which serves the purpose of a temporary plug. The curved form of the canula is well suited for the purpose of being retained in the wound. The chief objection to this process is the risk of the introduction of air into the chest. Several surgeons—Walsh, Bonnet, Guerin, Sanski, etc.—have proposed measures for removing by an exhausting apparatus, the fluid from the chest after the introduction of the canula; a syringe used as a suction pump, and a canula provided with a stop-cock, are the apparatus that has been most commonly employed for this purpose.

Terebration of one of the ribs.—*M. Reybard*, of Lyons, has revived the practice noticed in the works of Hippocrates, of evacuating the fluid of empyema by an opening formed in one of the ribs. An incision is to be made so as to expose the rib, and from this a central piece is to be removed with a small trephine or a drill. Into this opening a small canula is to be neatly fitted, so that it will remain securely fixed when screwed in. The pleura is then to be punctured at the bottom of the opening in the rib, and the canula, which had been previously fitted, inserted so as to give exit to the fluid. To allow the fluid to dribble away as fast as it is reproduced, without risking the introduction of air into the cavity, several means have been devised by *M. Reybard*, the best and most simple of which is said to be the following. The intestine of a cat, several inches long, previously moistened so that its sides will fall together and efface its cavity, is to be securely fastened to the outer end of the canula. When the fluid of the cavity escapes through the canula by its own weight, or as the consequence of a muscular effort, it is said to open the cavity of the intestine and flow out at its free end—the yielding walls of the intestine, which close immediately behind the descending stream of fluid, acting as a valve to prevent the introduction of air—the risk of which may be still further diminished if necessary, by giving to the piece of intestine some spiral turns.

There would, in the author's estimation, be reason to fear that this terebration of the ribs would be liable to be followed by caries.

Wound of the intercostal artery.

In case this artery, or one of its large branches, is divided in the process by incision, the open orifice should be tied before the pleural sac is punctured. If the vessel should have been opened in the operation by puncture, a circumstance which is but little likely to happen so as to occasion trouble, or by any accidental

wound of the chest, the bleeding may be arrested by one of the two following plans.

1. *Compression from within outwards by the process of Desault.*—The external orifice of the wound, if not sufficiently large, may be slightly dilated. Through the wound, the middle of a fine linen compress is to be insinuated into the cavity of the chest in the form of a sac. This is to be stuffed from without by charpie. The free margin of the compress is then to be drawn strongly outwards, by which means the stuffed cavity of its sac will act as a tampon upon the vessel between the ribs, while it leaves a smooth surface on the side next the cavity of the chest. Another pad is to be laid upon the external wound, over which the edges of the linen compress are to be secured. In the course of a few days, the apparatus may be removed, by picking out the charpie piece by piece from the cavity of the sac, and then extracting its envelop.

2. *By ligature.*—The simple ligature of the wounded intercostal artery would be, however, incomparably the surest means of arresting the bleeding, though, from the risk of injuring the pleura and admitting air into the chest, operators have in general shunned its performance. *When the opening already exists*, the ligature of the artery—which is a process not particularly difficult, though requiring the exercise of great caution—*might, it appears to the author, with propriety be attempted.* The incision of the soft parts for enlarging the wound should be made by raising up the integuments with the left hand, so as to get a valvular fold over the course of incision. The external layer of muscles must be divided over the intercostal space. The external intercostal muscles must also be raised and opened for the space of a few lines on the director; between this and the internal intercostal muscle, on the anterior two-thirds of the chest, will be found running the artery and the various branches which it sends off. If the trunk of the artery is sought for in the region of the posterior third of the chest, it will be necessary to divide cautiously both intercostal muscles on the director, feeling with the finger that there is no branch in the way of the knife, and look for the vessel on the surface of the pleura, and close to the under edge of the rib. A smooth blunt hook may now be pressed up against the lower edge of the rib, for the purpose of compressing the trunk of the vessel, and suspending the bleeding. The pleura is then to be cautiously separated from the muscles and edge of the rib with the finger, and the artery drawn out from the gutter in which it is lodged with the point of a curved director, and tied.

PARACENTESIS OF THE PERICARDIUM.

This is an operation which has been advocated by some practitioners, though rarely ever performed. It is well understood that accidental traumatic injuries of the pericardium, or even of a portion of the substance of the heart itself, are not necessarily fatal, yet in the absence of positive experience as to the results of tapping the cavity when in a morbid condition, the operation would be one necessarily attended by a great weight of responsibility. In the cases of *Desault* and *Larrey*, who both attempted its performance, it is believed the sac of the pericardium was not opened at all—a serous cyst attached to the mediastinum having been punctured by one surgeon, and a portion of the pleural

cavity by the other. The acknowledged difficulty of diagnosing without risk of mistake the existence of dropsy of this cavity, deterred in a great degree the older surgeons from attempting the operation. This difficulty of diagnosis has, to a very considerable extent, been diminished by the improved means of exploration which the science now possesses, so as to remove, as believed by some, one of the chief objections that have been urged against its performance. That, however, which in the estimation of the author should serve most as a counter-indication to the operation, is the fact that in dropsy of the pericardium, without organic lesion of the heart, there is always hope of removing the fluid by medical treatment, and that where organic lesion exists, its performance could at best effect merely temporary relief. Two methods have been proposed for its performance—the perforation of the sternum, and the opening of one of the intercostal spaces.

Surgical anatomy.—In its healthy state the heart is situated with its base at the middle line of the thorax and presenting towards the right shoulder, and with its apex turned to the left side, so as to correspond with a point between the fifth and sixth ribs, from two and a half to three inches to the left of the middle line. It is covered by the left half of the sternum, and the cartilages of the third, fourth, and fifth ribs, with their two intervening intercostal spaces. Exterior to these parts are found the skin and superficial fascia, a portion of the origin of the pectoral muscle, and at the fifth rib, the attachments of the pectoralis minor, external oblique and rectus abdominus muscles. The internal mammary artery runs down about the third of an inch from the border of the sternum, and sends off an external branch through each intercostal space. The pericardium, which is lined upon either side by the pleura, is attached by its inferior portion or floor to the tendinous centre of the diaphragm, and covered on its upper and front surface by a part of the left lung. When the pericardium is distended by a dropsical accumulation, it presses away the lungs in all directions, lowers slightly the diaphragm, and extends laterally especially towards the right side, (where, on account of the interval of the anterior mediastinum, it meets with the least resistance,) so as to bring the point of the heart a little nearer to the left margin of the sternum. If there is no adhesion between the pulmonary and the pericardial serous lining, the distended pericardium may be placed in contact with a broad surface of the ribs; but if, as is most commonly the case where the affection is of a chronic nature, such adhesion does exist, the thinned margin of the lung may be firmly attached like a cap over the pericardium, nearly up to the anterior mediastinum. Should this attachment have taken place, there would be risk of wounding the lung in paracentesis—a result which occurred in an operation by Desault.

1. *Paracentesis by trephining the sternum.*—A crucial incision is to be made over the left side of the inferior end of the sternum, and the cutaneous flaps reverted. The attachment of the pectoral muscle is to be loosened with the knife, and turned outwards. A piece of the sternum is then to be removed with a large trephine, and the posterior sternal aponeurosis below opened cautiously with the knife, at a point where the fluctuation of the pericardium can be felt; the patient being caused to lean forward to keep the pericardial sac in contact with the bone.

2. *By perforation of one of the intercostal spaces.*—Desault opened the space between the cartilages of the sixth and seventh ribs, and introduced a finger into the wound to distinguish the fluctuation of the fluid and serve as a guide to the bistoury. His patient died, and it was found on examination that the surgeon had opened a serous cyst upon the side of the pericardium. The place of puncture in this process is considered to be too low and too far from the median line, and is attended by a risk of wounding the diaphragm. Senac proposed to make the puncture between the fifth and sixth ribs. Baron Larrey has suggested a plan of getting at the pericardium by opening the triangular space between the left margin of the xiphoid appendix of the sternum and the cartilage of the seventh rib. The after-treatment in paracentesis of the pericardium is the same as in tapping for empyema.

VII. OPERATIONS UPON THE ABDOMEN.

The operations described under this head consist—1. Of those for Dropsy of the Abdominal Cavity. 2. Of those for Wounds of the Abdomen and Intestines; and, 3. Of those for Hernia.

OPERATIONS FOR THE CURE OF ASCITES.

The object of the various surgical measures proposed for the relief of this affection, is either the evacuation of the fluid by puncture, or the promotion of its removal by absorption. The fulfilment of the latter object—which has been attempted by a resort to compression with bandages, by blisters, and the insertion of five or six acupuncture needles repeated at intervals of four or five days—is but seldom accomplished. When well directed medical remedies fail to cause its removal, the evacuation of the liquid by paracentesis is the only practice deserving of reliance. It may, conjoined with the continued use of the remedies just mentioned, lead in many instances to a successful result when the dropsy is purely idiopathic, and should be practised if the swelling be large as soon as we are convinced that it has become stationary. When the dropsy is symptomatic of an incurable disease of one of the abdominal viscera, the operation will still be rendered necessary as a palliative measure, though the dropsical distension will in general be found sooner or later to return. In the latter case the rule of practice is the reverse of that in the idiopathic form of the affection; and the operation is to be deferred until the discomfort of the patient renders it necessary for his relief. With this tendency to re-accumulation of the fluid, the operation may require to be repeated, and the records of the science show that it has been found necessary to perform it on the same patient an almost incredible number of times in an extended series of years.

The trocar, which may be either round or flat, according to the will of the surgeon, is the instrument ordinarily used in making the puncture. It is to be introduced in the manner described at page 13 of this work. Dr. Physick preferred, in paracentesis of the abdomen, as a means of diminishing pain, to precede the

insertion of the trocar by a vertical puncture with the thumb lancet. This modification of the common plan of puncture, the author believes highly useful when there is considerable accumulation of fat below the integuments. The canula, armed with the ordinary trocar, should be passed immediately on the withdrawal of the lancet. The introduction of the canula on a blunt-pointed stilet, as practised by some operators, is an objectionable proceeding, inasmuch as it is attended with no corresponding advantage, and may cause additional pain and irritation if it wanders from its route.

Place of operation.—Among American and English practitioners, the linea alba is the point selected, as this involves no risk of injury to the epigastric artery, or any other important structure, provided that care be taken that the bladder is previously emptied. The lower portion of this line would appear preferable as facilitating best the discharge of the fluid; but for fear of injuring the bladder, the puncture is made within the space of two or three inches below the umbilicus, and exactly in the middle line for the purpose of avoiding the injury of either of the recti muscles. In case of necessity, it may be made at the umbilicus, or in the course of the line above the umbilicus, though this, unless the distension be great, would involve some risk of injury of the liver, (if this organ, as is frequently the case, should be found enlarged,) or of the stomach or transverse arch of the colon. French surgeons in general follow the practice of Sabatier, and make the puncture in the middle of a line drawn between the umbilicus and the anterior superior spinous process of the left ilium. The epigastric artery will *usually* be found to the inner side of this point, and the bladder and uterus at some distance below. It has lately been proposed by M. Récamier, to make the puncture in cases of females, at the posterior and upper part of the vagina, in order to reach the bottom of the peritoneal cavity between the rectum and uterus. This method, however, has not proved so successful in practice as to warrant its general use; and the fear of encountering the adhesions and displacements so usual in this region, appears to present insuperable objections to its adoption. When ascites is complicated with congenital hydrocele, it was advised by Morand and Ledran to discharge the fluid by a puncture of the vaginal tunics, a practice to which the author has resorted with advantage. In cases of encysted dropsy or abscess of the peritoneal cavity, the most prominent point of the tumour at which fluctuation is manifest may be selected for the operation.

Operation.—The patient is to be seated on the side of the bed, so placed as to render the region prominent upon which the puncture is to be made; and the projection of the part may furthermore be increased by pressure with the hands of an assistant stationed for the purpose behind the patient. The trocar is then to be inserted in the manner already described. The fluid flows spontaneously as soon as the stilet is withdrawn from the canula. If the canula becomes obstructed by any flocculent portions of lymph or albumen, or by the lodgment against its orifice of the omentum or small intestine, the round end of a probe may be introduced to restore the current, when this cannot be effected by the inclination of the canula to one side. As the abdominal walls will become lax from the discharge of the fluid, increasing pressure is to be made with the hands of the assistant, or better still, by a body bandage drawn on the side of the spine for the double object of evacuating

the remaining fluid, and supporting the walls of the ascending vena cava and other abdominal vessels, which, from the sudden cessation of pressure, are liable to become distended with blood, and give rise to syncope, by an interruption of the current to the heart. The canula is to be withdrawn at the completion of the operation, and the wound closed with a piece of adhesive or soap plaster. A compress and a body bandage, or a flannel roller well applied, completes the dressing. The pressure with the bandage should be continued for a considerable period if it be well borne, in order to present an obstacle to the rapid re-accumulation of the fluid.

M. Baudens evacuates the fluid gradually by a small canula—inserted obliquely under a fold of skin, as in the manner of a subcutaneous puncture—allowing it to remain for several days in the wound—drawing off but a portion of the fluid at intervals of six or twelve hours, and keeping the orifice closed by a plug in the intervals.

The author, in consequence of the favourable result he has seen attendant upon a constant dribbling of the fluid after the ordinary operation of tapping, was induced to employ a method similar to this some six or eight years ago in the Philadelphia Hospital, but abandoned it from its apparent tendency to excite peritoneal inflammation.

Where the umbilicus is pouted out by the dropsical effusion, which is apt especially to be the case in children, I have lately discharged the fluid by grasping the sides of the protruded umbilicus, and passing a bistoury through at its inferior part, so as to form a small semilunar flap, through which the fluid could escape and dribble away for two or three days in succession, without the necessity of introducing any instruments into the cavity of the abdomen. I recently removed in this manner, in conjunction with Drs. Janney and Shallcross of this city, a large ascitic collection from a delicate infant but a few months old. The result was most happy; not the slightest irritation followed the operation and the fluid was not regenerated.

PENETRATING WOUNDS OF THE ABDOMEN. (PL. LVII.)

SIMPLE WOUNDS.

In simple wounds of the abdomen an inch or more in length, which merely open into the peritoneal cavity, the intestines and omentum are liable to be protruded in the form of hernia. In these cases, the viscera are uninjured, and little is required to be done but to wash off carefully with warm water all irritating or foreign substances with which they chance to be covered, and return them into the abdomen as speedily as possible. The process for reduction is analogous to the taxis in the ordinary forms of hernia, care being taken to raise the hips and chest in order to relax as much as possible the abdominal walls. When the reduction is effected, the wound is to be closed by the interrupted or quilled suture, supported by adhesive straps and a body bandage.

Wounds with strangulation of the protruded viscera.

When a large mass of intestine has been protruded through a narrow wound—or in cases where the protrusion is not extensive,

but the viscus, from the length of time it has been out, has become swollen, distended, inflamed or gangrenous—some form of operation will be needed.

Strangulation of the omentum alone.—If the wound be but small, and there is simple strangulation merely of a little knot of omentum, occasioning no pain to the patient, or any uneasiness in different attitudes of the body, it is directed—provided it cannot be reduced without dilatation of the wound—to leave it protruded, after having carefully ascertained that it contains no loop of intestine. If, on the other hand, it is large, produces pain in attempts to straighten the trunk, or gives rise to the general symptoms of strangulation, the orifice is to be dilated with a probe-pointed bistoury and the viscus returned. The dilatation, according to Sabatier, should be made at the inferior angle of the wound, in order to diminish the risk of wounding the omentum, which will be found stretched between the upper angle of the wound and its root of attachment to the stomach and colon.

When the omentum is protruded from a wound and more or less injured, it will be necessary for the surgeon to exercise much discretion as to the course he should pursue. The following case, though it should not perhaps serve as a precedent, had a fortunate issue, when the parts had, under such circumstances, been returned. I was called in consultation by Dr. Davis, of this city, to the case of a lad, wounded in the riot of 1844, with a pistol shot, in the left iliac region. The ball, which was large, had penetrated the walls of the abdomen, an inch to the inner side of the anterior superior spinous process of the ilium and lodged somewhere in the cavity. No vessel of importance was injured, but through the large ragged orifice protruded a mass of omentum the size of a goose egg, the folds of which had been perforated by the shot. There was no bleeding from the omentum, which, though mottled and ecchymosed by the contusion, did not seem to have lost its vitality. By the use of a soft elastic catheter, I reduced the protruded omentum without difficulty and without enlarging the orifice of the wound. The boy recovered perfectly, and had no bad symptoms except a local peritonitis and some pain at the hip-joint, as he commenced to move about, which was probably owing to the presence of the ball in that vicinity.

If the strangulation has been such as to produce gangrene of the omentum, the mass may either be left without till it sloughs away, as is commonly directed, or shaved off upon a level with the surrounding skin. If the latter course be pursued, it will be proper to tie the orifices of the divided vessels, for fear they might give rise to internal hemorrhage in case reduction should spontaneously take place.

Strangulation of the intestine alone. (Pl. LVII. fig. 1.)—In simple strangulation of a loop of intestine, which it is impossible to return by a gentle trial of the taxis, it is necessary to enlarge the wound by an incision at its superior angle. The degree of enlargement should not, however, be more than absolutely necessary to allow readily of the return of the intestine, for fear of increasing the risk of a subsequent hernial protrusion.

Operation.—The patient should be placed upon his back with his head and chest elevated, and his thighs flexed upon the pelvis, in order to relax the abdominal muscles. The surgeon depresses the mass of intestines with his left hand, and dilates the wound with a probe-pointed bistoury, introduced over the nail of the

left fore finger, or along the groove of a director when there is sufficient space for the previous introduction of this instrument. If the wound has occurred in a muscular part of the abdominal parietes, the separate layers of muscles, fascia, and peritoneum should be divided in succession.

Strangulation of the intestine through an opening made in the omentum by a wound involving the abdominal walls. (Pl. LVII. fig. 2.)—In instances of this description, the orifice in the omentum must be dilated with the bistoury introduced on a grooved director, as shown in the drawing, before the intestine is returned into the cavity of the abdomen. Scarpa has noticed a case in which the strangulation occurred in this way, without the escape of the intestine through the external wound.

If the intestine has become gangrenous from the effect of the strangulation, a result which seldom occurs in these cases except after the lapse of one or two days, the only hope of cure is in the formation of an artificial anus, and the mode of treatment will be the same as in ordinary forms of hernia, when the intestine is found in a similar condition. The surgeon is to wait—unless there is an urgent necessity for prompt relief—two or three days, so as to give time for the abdominal portion of the protruded intestine to become firmly adherent to the peritoneal margin of the orifice, when he is to open the intestine, and allow the contents of the bowels to escape.

WOUNDS OF THE INTESTINE. (PL. LVII.)

In penetrating wounds of the abdomen, it is oftentimes exceedingly difficult to determine whether or not one of the intestines has been wounded. These organs are flaccid and movable, especially when not distended with alimentary matters or by an accumulation of gas, and somewhat prone, notwithstanding they are in contact with every part of the abdominal walls, to fly before the edge of a cutting instrument, so that they may either be opened at one or more points, or escape altogether in cases where, from the nature of the injury, such a result would seem almost impossible. In this state of uncertainty, we must, when the wound is too narrow—as in a sword thrust—to allow us to determine the exact nature of the lesion, trust alone to the efficacy of appropriate medical treatment.

Those cases alone demand consideration here, in which the wound is sufficiently large to admit of the protrusion of the intestine, or allow of the examination of the wounded part when it is retained in situ. Even under such circumstances the wound of the intestine, if it be but a mere puncture, or not more than three or four lines long, is susceptible of being closed spontaneously, as shown by the observations of Sir A. Cooper and Mr. Travers; the mucous membrane—from the contraction into which the intestine is thrown by the stimulus of the wound—becoming everted through the orifice so as to block it up and prevent the escape of fecal matter, even where the intestine has been returned into the cavity of the abdomen. Though the lips of the wound in the intestine are prevented by the protruding membrane from directly uniting together—for two mucous surfaces never unite—the orifice becomes permanently closed by the effusion of lymph from the peritoneal lining of the intestine near the cut, which even in the course of forty-eight hours, unites the

injured organ to some adjoining serous surface, whether it be that of another portion of the bowel or the wall of the abdomen itself. In cases, however, where the intestine thus injured is protruded from the wound, it would be more prudent to close the orifice before returning it by a simple stitch, and cut off the ends of the thread, leaving the knot, as directed by B. Bell, to escape subsequently by making its way into the cavity of the bowel. Dieffenbach in these cases takes up with the needle the outer tunics of the intestine, (Plate LVII. fig. 11,) so as not to include the mucous coat in the stitch. Sir A. Cooper was in the habit of raising the sides of the orifice on a tenaculum and surrounding it with a thread, (Plate LVII. fig. 6,) nearly as in the manner of tying an artery; this plan, however, is objectionable, inasmuch as the strangulation, even of a small part of the wall of the intestine, may give rise to the general symptoms of stricture, and even should the patient escape this risk, occasion a narrowing of the bowel.

In wounds of larger size than those above noticed, in which there is greater risk of effusion of the contents of the intestines, the plan of treatment will depend much upon the direction of the cut. If the wound be transverse, the longitudinal fibres will con-

tract so as to widen its orifice, and though the action of the circular fibres may cause an eversion of the mucous membrane, it will not be of such an extent as to block up the opening, and the feces will escape unless the wound be closed by surgical aid. A longitudinal wound of the intestine is not on the whole attended with so much danger as a transverse one of the same extent, as there will be less widening of the orifice by the contraction of the muscular fibres. Both will, however, if more than three or four lines long, require to be closed by suture. Various modes of applying sutures for this purpose have been devised so as to close the orifice without interruption of the intestinal tube. Such measures have been proposed even when the intestine has been in a great part or entirely divided across. It should, however, be remembered, that notwithstanding the great progress which has latterly been made in this department of surgery, the greater number of processes devised are to be considered rather as the fruits of theory, or of experiments upon inferior animals, than the results of actual experience on the human subject. As a general rule the simpler methods—those which are likely to be followed by the least irritation or inflammation—should be preferred, on account of the high functional importance of the parts

PLATE LVII.—WOUNDS OF THE ABDOMEN. SUTURES OF THE SMALL INTESTINES.

Fig. 1.—*Dilatation of an abdominal wound* for the purpose of reducing a mass of the small intestines which had escaped without. The folds of intestine are represented as having been gently drawn down with the fingers of the surgeon's left hand, so as to admit the insertion of the fore finger into the top of the wound. Over the nail of this finger, the back of a probe-pointed bistoury is passed for the purpose of dilating the orifice.

LONGITUDINAL WOUNDS OF THE INTESTINES.

Fig. 2.—A longitudinal wound of a portion of the small intestine which has escaped through a cut in the abdomen, is here seen closed by the continuous or glover's suture. The surgeon is represented as holding the two extremities of the thread in his left hand, while with his right he returns the intestine.

Fig. 3.—*Suture of Ledran.*

Fig. 4.—*Dilatation on the grooved director* of an opening in the omentum, through which a hernial protrusion has taken place. The suture of the wound in the loop of the small intestine is made by the process of Beclard.

Fig. 5.—*Suture by the process of Jobert.*

Fig. 6.—*Suture by the process of Sir A. Cooper.*

Fig. 7.—*Suture by one of the processes of Reybard.* This may be well understood by reference to the drawing.

a. The wooden plate shown separate.

b. The plate thus applied on the inner face of the intestine, to the wall of which it is attached by a ligature. It has been proposed in transverse wounds of the intestines. It has not been thought necessary to describe it in the text.

Fig. 8.—*Suture by the process of Lembert.*

a. Application of the ligatures.

b. Action of the suture in closing the orifice by bringing two serous surfaces in contact. This process is applicable both to transverse and longitudinal wounds of the intestines.

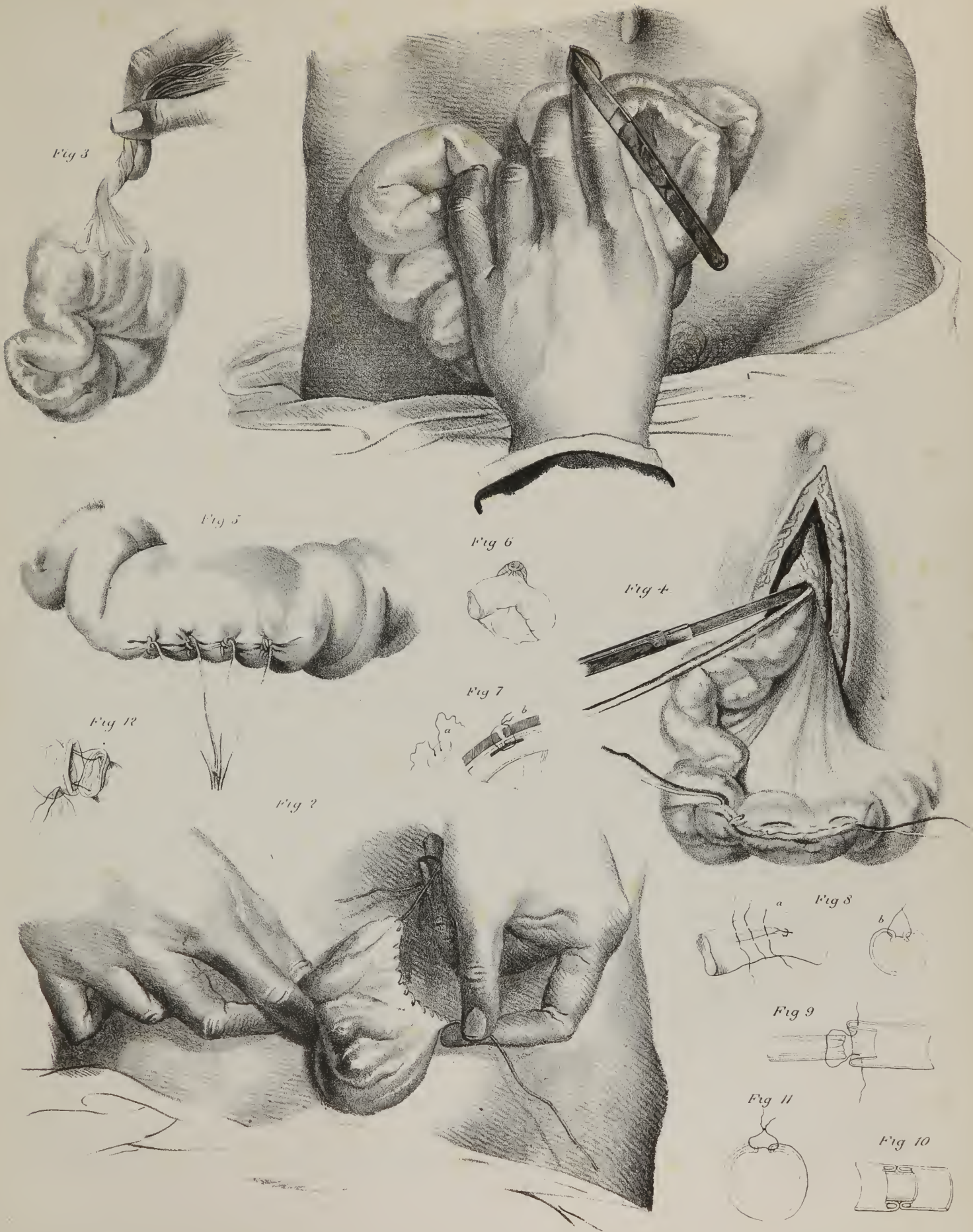
TRANSVERSE WOUNDS.

Fig. 9.—*Invagination by one of the processes of Jobert.*

Fig. 10.—*Process of Denans*, in which the ends of an intestine divided across are approximated by the means of a cylinder and two rings.

Fig. 11.—*Process of Dieffenbach*, in which the ligature is passed merely through the outer coats of the intestine.

Fig. 12.—*Process of Jobert for invagination.*—The two ends of the divided intestine are brought in contact so as to show the manner in which the invagination is effected by the tying of the ligatures.



concerned. Though the author has given below the description of the ingenious processes for closing wounds of the intestines by the introduction of foreign bodies, such as rings and plates, into their cavity, he is disposed to think the advantage to be derived from them is in a great measure problematical. The simpler methods to which he would give the preference, consist in the fastening of each of the orifices of the injured intestine by means of a suture at the peritoneal margin of the wound, trusting to the effusion of plastic lymph to prevent the escape of fæcal matters into the abdominal cavity, or of drawing them in cases of complete division well into the outer wound for the purpose of forming an artificial anus. When the bowel does not protrude, and the opening in it is situated immediately behind the orifice of the external wound, a suture of no kind is required, (which could seldom in such cases be employed without dilating the wound or disturbing the intestine,) inasmuch as there is little or no danger of the injured bowel changing its position, provided the patient be kept perfectly quiet and in the horizontal posture.

Longitudinal wounds of the Intestines.

Various forms of suture are employed for the closure of wounds of this description.

1. *Process of Ledran.* (Pl. LVII. fig. 3.)—The intestine is to be extended longitudinally so as to bring the lips of the aperture together, through both of which, ligatures are to be passed across with a fine cambric needle at intervals of about two lines. The two ends of each thread are then to be brought out of the wound, and the whole of those of each side twisted lightly into a cord, so as merely to bring the lips of the aperture together; the two bundles are then brought out as a single cord, and attached by an adhesive strap near the internal margin of the wound. If the application of the process proves successful, the wounded surface of the intestine will be found agglutinated, by means of lymph, to the adjoining surface of the peritoneum. The same object may be accomplished by the following process.

2. *Process of Palfyn.*—This consists simply in passing a thread across the middle of the wound, so as to bring the aperture of the intestine towards the orifice of the external incision. The ends of the thread are to be fastened to the skin by strips of adhesive plaster.

3. *By the glover's suture.* (Pl. LVII. fig. 2.)—This was the process chiefly relied on by the older surgeons. It consists merely in stitching the two edges of the wound with a continuous thread, and will be well understood by reference to the drawing. It is important that the loops of the thread should not be drawn more tight than is sufficient merely to close the fissure, lest they should cut the tissue by ulceration. The two ends of the thread should be left long, as seen in the drawing. As soon as the thread is applied, the surgeon sustains it with his left hand (or gives the ends to an assistant), while he reduces the protruded intestine with the other, and finishes by drawing on the ligature, so as to retain the wounded surface of the bowel in contact with the orifice of the abdomen, which is to be carefully closed. At the end of five or six days the thread is to be withdrawn by pulling gently upon one end, while a support is made with the fingers of the other hand upon the abdominal walls.

4. *Process of Beclard.* (Pl. LVII. fig. 4.)—This is a modification of the preceding, and consists in basting the edges with two

threads of different colours passed at the same time through the eye of the needle. An end of a different colour is retained without at either extremity of the wound. The only advantage arising from this modification is, that at the proper time for their removal the threads may be withdrawn by pulling at the same time on the two ends without wrinkling the bowel, and thus with less risk of breaking up its new adhesions. In all the preceding processes the mucous surfaces of the intestines are merely put in contact, and as these do not unite, the closure of the orifice in the bowel is only effected by the medium of the lymph by which it becomes agglutinated to another peritoneal surface, as that of an intestine or the wall of the abdomen. In the succeeding process, the peritoneal surfaces of the two lips of the wounded bowel are brought in contact.

5. *Interrupted suture. First process of Jobert.* (Pl. LVII. fig. 5.)—This surgeon presses together the two lips of the wounded intestine with the thumb and finger of the left hand, and with the needle in his right inverts the edges so as to bring the two serous surfaces in contact. Several interrupted sutures two or three lines apart, are then made through both the inverted edges, in order to keep the serous surfaces together. They are to be knotted separately; one end of each ligature is to be cut off near the knot, and the remaining ends, after the intestine has been returned into the abdomen, brought out and retained at the external wound. By the fourth or fifth day the knots cut loose, so that the threads may be withdrawn. If the operator prefers, the ends of the threads may be simply twisted, as in the process of Ledran—or both ends of the ligature may be cut off after they have been knotted, leaving the knot to fall by ulceration into the cavity of the intestine, and escape with the fæcal matter. This last modification would allow of the immediate closing of the external wound, without the interposition of any foreign substance between its edges. Its value, however, has not been tested by experience.

6. *Process of M. Reybard.*—This surgeon employs the glover's suture, but so modified as to leave the thread to detach itself spontaneously, and fall into the cavity of the intestine. He uses a small needle with a double thread, which is knotted at the end upon a small cylinder of linen. The thread is introduced from within outwards at one end of the cut, so as to leave the cylinder in the cavity of the intestine. The edges of the wound are then closed as in the ordinary glover's suture. When the needle is brought to the other end of the cut, one end of the double thread is slipped from the eye; a stitch more is made with the remaining end, and the two ends are finally knotted firmly together and cut away close to the knot. The intestine is then to be reduced, and the wound united. The cylinder is employed for the purpose of offering more resistance to the contraction of the intestine than would occur from a simple knot, thus facilitating the ultimate discharge of the thread, which is abandoned in the wound.

Transverse wounds of the Intestines.

Three principal methods have been employed in the closure of transverse or oblique wounds of an intestine; viz: suture upon a foreign body, suture with invagination, suture by the conjunction of the serous surfaces.

1. *Suture upon a foreign body. (Process of Duverger.)*—This is but a modification of the process known under the name of “the four masters,” in which the orifices of the wound were stitched over a section of the trachea of some animal. M. Duverger employed a section, two-thirds of an inch long, of the dried windpipe of a calf, steeped in oil varnish. This was introduced into the cavity of the bowel, so as to preserve its calibre, and fastened in its position by three loops of interrupted suture. The intestine was then to be returned, and some gentle laxative drink given to the patient. This operation has in several instances been followed by complete success, the foreign body having been evacuated by stool. A canula of isinglass, a cylinder of tallow, or a piece of cord rolled in the form of a tube and steeped in the oil of hypericum to prevent its softening too speedily, have been respectively proposed by Watson, Scarpa, and Chopart, as a substitute for the foreign body of Duverger. The process has, however, gone out of use.

2. *Suture with invagination.*—In a case where the small intestine was completely divided across, Rhamdor, of Brunswick, conceived the idea of introducing the superior end of the intestine into the inferior, keeping them in conjunction by two points of suture, returning the bowel immediately afterwards into the abdomen, and closing the external wound. This operation succeeded completely in the hands of its projector. But on the dissection of this subject some years afterwards, it was found that the union which had maintained the route of the bowel was made by adhesions between the surrounding serous surfaces, and not by a junction of the serous coat of one end with the mucous coat of the other, which had been put in apposition. The operation has been several times repeated since, but in the greater number of cases with an unsuccessful result. It has latterly been revived, with some modification, by Amussat.

Two difficulties attend this process, which at times must render it wholly inapplicable:—1. That of distinguishing the upper from the lower end of the divided tube, since, from the convoluted arrangements of the small intestines, that which is at the upper end of the wound will often be found the orifice leading to the inferior tract. The only means of determining this question positively, is to give the patient some milk or a slight laxative potion, and notice by which orifice the discharge takes place—the two ends of the intestine being retained without for that purpose. In reference to the large intestine, the liability to mistake is not so great, and in case of doubt, may be determined at once by the administration of a mild enema. 2. The second difficulty attends the process of invagination itself. This arises in part from the obstacle which the mesentery presents to the introduction of the superior extremity into the aperture of the lower, and is to be obviated by its detachment to a sufficient extent from the side of the bowel: or the two orifices, and especially the lower, may be found plicated or contracted with an eversion of the mucous membrane, so that the introduction of some foreign body is rendered necessary to keep the track of the bowel patulous after the invagination. This latter difficulty has been met by the following ingenious proposition of M. Reybard, the value of which has not, however, to the knowledge of the author, been tested by its application to the human subject.

Process of Reybard.—This consists in introducing a piece of

card, rolled in the form of a short cylinder, into the orifice of the upper end of the bowel, to which it is to be fastened by two loops of thread that embrace opposite portions of the cylinder; the ends of the threads are brought out through separate punctures in the wall of the intestine. The two ends of each of the threads are next passed separately from within outwards through the walls of the lower orifice, and are made the means of drawing the other end of the card and the upper orifice of the intestine into the lower end of the tube. The two ends of each of the threads are now knotted on opposite portions of the bowel. Another process of this surgeon, in which he employs a wooden plate instead of the cylinder, is represented at Pl. LVII. fig. 7.

Process of Amussat.—This surgeon has proposed to bring together the divided ends of a small intestine, by introducing a ring of cork, with a sort of hour-glass narrowing in the middle, into one of the orifices of the intestine. This end, kept patulous by the cork ring, is then well invaginated in the lower orifice, and a large thread is passed round and knotted so as to firmly attach the two coats of intestine to the groove in the cork. The ends of the thread are to be detached close to the knot, and the free portion of the outer orifice pared away with the scissors close down to the thread. This process has not, however, yet been applied upon the human subject.

3. *Suture with junction of the serous surfaces. Second process of Jobert.* (Pl. LVII. fig. 12.)—The only apparatus used is two threads, armed each with a needle at either end. The mesentery is first to be detached for a third of an inch on both ends of the intestine. One end of each thread is then to be passed from within outwards, through the wall of the upper orifice of the intestine, at a distance of three lines from its edge. The two loops of threads thus formed should be at opposite points of the intestine. They are to be held by an assistant, while the surgeon takes hold of the inferior end of the intestine and doubles in its border, so as to make it present its serous surface externally. The needles at the ends of the two loops of thread are then brought at different points from within outwards through the folded edge of the lower orifice. By drawing upon these threads, the upper end of the bowel is invaginated in the lower, so as to place the two serous surfaces in contact. The threads are then to be knotted or merely twisted tight, and the intestine reduced. The value of this ingenious and somewhat celebrated process, has not yet been tested in its application to man.

Process of Denans. (Pl. LVII. fig. 10.)—In the ingenious process of this surgeon, a silver cylinder is required about two-thirds of an inch long, and two flat rings a third of an inch broad and sufficiently large in their diameter to slide over the ends of the cylinder and allow the edges of the bowel to be interposed between them and the cylinder, as seen in the longitudinal section shown in the drawing. The mesentery is to be detached from near the two orifices of the intestine, as in the process above described. The two rings are then introduced, one into each of the ends of the intestine. Over these, the free edge of the orifice is doubled in, in the form of a fold two or three lines long. The two ends of the cylinder are next inserted in the opposite orifices of the bowel, so as to compress the doubled edges against the inner surfaces of the rings. The continuity of the intestinal passage is now restored, the free serous edges of the tied inverted margins

of the orifices being placed in apposition over the centre of the cylinder. It now only remains to fasten the rings together so that they shall not separate, before such an effusion of lymph has taken place as will preserve the continuity of the tube. This is accomplished by a thread armed at each end with a needle; one needle being passed through the intestine opposite the lower margin of the cylinder, carried into the cavity of the intestine, and brought out by another puncture through the intestine at the opposite end of the cylinder, bringing with it one end of the thread. In the loop of the ligature are now embraced the cylinder, the ring, and the portions of the intestine which rest upon these parts, all of which would, if the thread was knotted, unavoidably be strangulated. To avoid the strangulation, the second needle is to be entered and brought out at the same places of puncture as the first, *but this time passing between the mucous surface of the bowel and the external face of the rings*. The two ends of the ligature which have been brought out at the same puncture, are next to be knotted, cut off close to the knot, and the knot itself pushed through the aperture of the puncture into the cavity of the intestine, so that no foreign substance shall be left on the outer surface of the bowel when it is returned into the cavity of the abdomen.

The result of this process, as shown by experiments upon dogs, is the union by adhesion of the serous layers upon the folded margins of the two portions of intestine, and the detachment by gangrene of the inner ends of the folds included between the rings and cylinder, so as to loosen these bodies and allow them, with the loop of ligature, to be evacuated by stool.

For fear that the metallic cylinder and rings might, if applied upon the human subject, become arrested in their passage down the bowels, it has been proposed to have them fabricated of some substance, as gelatin steeped in a drying oil, which, while it remained unchanged a sufficient length of time for the adhesion of the serous edges to take place, would in the end, by becoming partially dissolved, be readily expelled.

Process of Lambert. (Pl. LVII. fig. 8.)—This surgeon, without employing any foreign body, proposes to put the serous surfaces largely in contact by a peculiar mode of applying the ligatures. Each ligature is to be passed with a needle—introduced from the serous coat four or five lines from the divided end of the bowel, and carried, not through into the cavity of the bowel, but between the membranes of the parietes to within a line or two of the open end, when it is again brought through the serous membrane; taking as it were merely a stitch through the outer coats of the bowel. The needle is now passed in a similar way upon the other end of the intestine, with the exception merely that the first puncture is made near the orifice and the needle brought out by a second a few lines further on the bowel. When the ligatures are thus applied and knotted, it will be manifest that the ends of the bowel will be inverted, and the serous surfaces of both wrinkled up and put freely in contact. Three or four sutures are then to be applied around the intestine and cut close to the knot. The intestine is then to be returned into the abdomen. This process has been successfully employed by M. J. Cloquet upon the human subject, for the purpose of closing the wound of an intestine, made in the operation for hernia.

OPERATIONS FOR HERNIAL TUMOURS OF THE ABDOMEN.

GENERAL OBSERVATIONS ON HERNIA.

The escape of one or more of the viscera from the cavity of the abdomen, by the dilatation of one of the natural passages which lead from this cavity, or by a rupture of some portion of its walls, constitutes a hernia. The small intestines and omentum, which are the most movable of all the viscera, form the greatest bulk, and are placed in contact with the largest extent of parietal surface, are so generally, either separately or in conjunction, the subject of hernial protrusion, that the escape of any of the other abdominal organs is to be looked upon as an exception to the general rule. The next to them in the order of frequency is the sigmoid flexure of the colon, but the protrusion even of the liver, stomach and spleen, has been noticed in some rare cases of old and large hernia.

Hernial tumours have received names in conformity with the points at which the viscera escape. We have thus “inguinal hernia,” when the viscera pass by the inguinal canal; “crural hernia,” when protruded at the crural ring; and in like manner umbilical, perineal, thyroid, vaginal, ischiatic and diaphragmatic hernia, when these several regions become the seat of the protrusion; and in addition, ventral hernia, when the viscera escape by an accidental wound or rupture of any portion of the abdominal walls.

The protrusions in each of these forms of hernia are specifically named according to the nature of the organ displaced, viz:—“enterocele or intestinal hernia,” when the intestine is protruded alone; “epiplocele or omental hernia,” when the omentum only is the subject of displacement; “entero-epiplocele,” when both intestine and omentum are protruded together; “cystocele,” if the bladder, and “hysterocele,” if the uterus has escaped by a hernial passage. The viscera protruded in hernia are not exposed naked, except in cases where the cavity of the abdomen has been opened directly by a wound.

The different layers which form the covering of these several forms of hernia, constitute the most important feature in their surgical anatomy, and should be carefully studied by the surgeon, for he cannot, unless familiar with their arrangement, do any operation for the relief of stricture with proper precision, or with satisfactory prospect of success. The viscera, as they are protruded in hernia, push before them, as a general rule, the peritoneal lining of the inner surface of the abdomen. This membrane, with the cellular tissue upon its outer face, forms the inner and immediate investment of the tumour—that which has been called the hernial sac. This sac, with some exceptions hereafter to be noticed, is common to all herniæ; but the other coverings—fascial, aponeurotic, or muscular—vary according to the place at which the hernia appears.

Development of the sac.—This is formed, as just observed, by the protruding viscus, which, as it escapes through or by the side of one of the natural passages of the abdomen, carries down the peritoneum before it as a sort of cowl or cap. This sometimes takes place suddenly and without previous gradual dilatation, when the passages are preternaturally large, or the fascia and muscles

which should cover and protect them are unusually thin, or have been rendered preternaturally weak. In most instances, however, the complete protrusion of the viscus is more slowly effected. The pressure to which the viscera of the abdomen are subjected by the action of the diaphragm and abdominal muscles, which act in conjunction when great efforts are made so as to press the viscera between them, induces these organs to seek an outlet at any point which is not able to resist the pressure. When such a weakened point exists, it gradually yields or dilates more and more from each succeeding effort. The effort over,—the viscus and the cup-like process of peritoneum protruded before it, are in the early stages driven back by the reaction of the parts on the outer side of the dilating point. As the passage becomes more dilated and the parts protruded increase in bulk, the cup of peritoneum takes the form of a pouch or sac. This state of preparation for the complete hernial protrusion, may go on without the consciousness of the individual, till, from sudden and violent muscular effort, or from force applied externally, the viscus is so far protruded as to become visible by the formation of a tumour, or excite attention by the pain or functional disturbance it occasions. Under such circumstances, the sac for a time is still susceptible of being returned into the abdomen with the tumour; but if the displacement frequently recurs, the sac becomes unequally dilated; its bottom or protruded part meeting with the least resistance, enlarges more or less in all directions, while its upper part, girdled by the more rigid structure of the wall of the abdomen, remains narrow, and constitutes what is called the neck of the hernial tumour, the expanded part being termed its body. If the orifice at the neck is large, so as to allow the viscus to freely enter and return, the sac elongates itself by gradually drawing down more and more of the loosely attached peritoneum from the adjoining surface, and soon becomes so adherent to the parts on its outer face as to be incapable of being returned even after operation, without previous dissection with the knife. The enlargement of the sac may still subsequently go on, partly from a further descent of the peritoneum, partly by its own interstitial growth, and at times even by a distension and thinning of the membrane, which renders it occasionally, in old cases, only obvious as a distinct layer in the neighbourhood of its neck. As the body of the sac enlarges, it will extend in the direction in which it meets with the least resistance, however circuitous this may be, and sometimes from the same causes forms one or more pouches upon its sides, so as to give it a multilocular or cellular appearance. When the sac has in this manner attained considerable size, been rendered firmly adherent, especially at its neck, and has a large peritoneal orifice, it sometimes itself becomes the receptacle of another complete hernial protrusion—the lax peritoneum around the margin of its inner opening descending before the intestine or omentum in the form of a second pouch into the first, so as to constitute what is called an encysted hernia. This occurrence usually takes place at a time when the first formed pouch is empty. A new pouch may even form by the side of the old, and thus two sacs exist with separate orifices; and there is nothing to render it improbable, but that the orifice of the first may become so large as to admit the viscus into each sac so as to give rise to a double hernia at the same point.

Such, then, is a brief description of the usual manner in which the sac is developed. Its inner surface remains under ordinary

circumstances, smooth and polished, and retains its serous character. The fluid, however, which it secretes, varies in quality and amount in the various forms, and in the different states of the same form of hernia. The inner surface of the sac is subject to irritation from the undue or long-continued pressure of the protruded viscera, from external violence, or from the imperfect action of a truss. From either of these causes it is apt to inflame, throw out lymph and agglutinate itself to the serous coating of the protruded viscera (which always share in the inflammation thus produced), so as to prevent the latter from being returned, and convert what is called reducible into an irreducible hernia; or may form bands across its cavity which become not unfrequently the cause of strangulation. But the neck, which is the narrowest part, is the one most subjected to these changes. It is modeled upon the form of the opening in the abdominal wall, being annular when the protrusion takes place by a direct opening, as in crural or umbilical hernia, and more or less tubular, when it escapes by a canal, as in recent oblique inguinal hernia. In old cases of oblique inguinal hernia, the two ends of the canal are gradually approximated by the weight of the descending intestine, so that the neck finally obtains the annular shape.

In the early stages of hernia, the peritoneum is arranged in the form of plaits at the abdominal orifice, which unfold when the sac is returned into the cavity. But when the sac becomes adherent, these folds are disposed to unite together, so as to narrow the opening, render it more rigid and inextensible, and present a sharp valvular prominence, which, by preventing the return of the tumour, becomes the most frequent seat of stricture. The pressure of a well-applied truss has a tendency to hasten this retraction of the orifice, and in some favourable cases may in the end effect its obliteration so far as to prevent any subsequent protrusion. Sometimes the sac is thickened as a consequence of the inflammation; but more commonly than is generally believed the thickening which takes place is in the cellular structure on its outer side.

Hernia without a sac.—There are other forms of hernia, in which there is no separate protrusion of the peritoneum in the form of a sac. The most common kind of these is that to which, though without strict propriety, the term *congenital* has been applied. In this variety the peritoneal passage of the fetus which leads down the spermatic cord to the vaginal tunic of the scrotum, or that about the round ligament of the female, known as the canal of Nuck, has not been as usual obliterated, and the intestine or omentum is found after birth sliding into the passage, as into the sac of an old hernia;—or the obliteration may have been only partial, so as to yield under the stronger efforts to which it is subjected as the individual grows up, and give rise to what is called *congenital hernia*, even though it occur for the first time at the period of manhood. In these cases, which occur nearly always in the male, the protruded parts lie immediately in contact with the cord and testicle, and, though they do not protrude a peritoneal pouch before them, are nevertheless covered in front and on the sides by the reflected serous tunic of the testicle.

In some rare instances a hernia may be formed without the protruded parts having any serous covering, as when the cæcum escapes by its posterior cellular surface through the crural or inguinal rings, or the top of the front surface of the bladder is elongated, so as to pass out through the same channels.

Even in ordinary cases of hernia the sac may be ruptured by a blow, removed by absorption in consequence of the pressure of its contents, as has been observed by Sir A. Cooper and Breschet, or broken down by an abscess on its outer side, so that in case of operation the protruded parts will be found lying in contact with the cellular or fibrous coverings of the sac.

Each hernial tumour is found in one of the four following conditions:—*reducible*, *irreducible without strangulation*, *strangulated without adhesion*, and *strangulated with adhesion*.

A *reducible hernia*, is one in which the displaced organs can be returned into the abdomen by the patient himself, or by a methodical employment of the taxis on the part of the surgeon.

When the parts are temporarily displaced and largely distended in consequence of a stationary accumulation of gaseous or solid matters in the protruded intestine, attended with pain, constipation and nausea, we have what has sometimes been denominated *obstructed* or *congested hernia*. This is met with mostly in old hernia, and especially in those of old men. It may last several days, and terminate either by free evacuation per anum, or by inflammatory strangulation.

An *irreducible hernia*, is one which cannot be made to return by the use of the *taxis*, in consequence usually of the adhesions which the organs have formed with the sac. In some instances, however, of this description, when the hernia is small, reduction may be effected by returning the sac and tumour together into the cavity of the abdomen. The very bulk of the tumour, in some cases of enormous hernia, even though there should be no adhesions, (which rarely fails to be the case,) presents an obstacle to reduction, and constitutes what has sometimes been called “incarcerated hernia:” for when the bulk of the parts protruded is considerable, the abdominal cavity contracts in its dimensions, so as to accommodate itself to the loss of the organs, and presents an obstacle to their return. The simple irreducibility of a hernia is not of itself, under ordinary circumstances, liable to compromise the health, and the tumour may be protected against further enlargement by the wearing of a hollow truss, or, if too large to be supported in this way, by a well-fitting buckskin pouch.

A *strangulated hernia without adhesion*, is one in which the viscera recently protruded are rendered irreducible in consequence of being tightly constricted at or near the neck of the sac, so as to produce more or less general functional disturbance, and local symptoms of inflammation, which may run on to gangrene. Strangulation, however, is not to be mistaken for that state of the tumour which has been denominated obstruction.

In *strangulated hernia with adhesion*, which occurs in irreducible hernia, the mode in which the stricture is produced is much the same as that just described, and the importance of the distinction refers mainly to the treatment after operation.

Strangulation may be owing either to the smallness of the neck of the sac, so that a mere loop of intestine or knot of omentum is strangulated almost as soon as it is displaced, or when the neck is only rendered relatively small in consequence of the great bulk of the parts displaced. In strangulation there is always inflammation of the sac and of the parts enclosed, and this inflammation, which has been occasioned by the stricture, reacts most injuriously in its turn by rendering the strangulation more tight. It tends also to increase the quantity of fluid which is usually found in old hernial

tumours, renders it turbid from the effusion of lymph, or chocolate-coloured, if it has run on towards mortification. From the effusion of lymph there is also more or less gelatinous agglutination of parts, if the strangulation has existed some hours; it is found even at the neck of the sac in those cases that have been most speedily operated on. These new adhesions are, however, easily ruptured with the end of the finger, or by slight traction, and may be distinguished from the older ones, which are more resisting. Another much more serious result of the strangulation and the inflammation which accompanies it, is the gangrene of the parts enclosed, produced oftentimes with the most extraordinary rapidity by the twofold effect of the inflammation and the subsequent arrest of the capillary circulation.

It is important for the operator to be familiar with the different appearances which the parts present between the first period of strangulation, and that which has resulted in gangrene.

1. *Appearance of the intestine*.—At the first period of strangulation the intestine will be found tense, smooth, and shining, with a violet tint, which, as it is merely the consequence of obstruction in its circulation, soon diminishes, on the division of the stricture. At a later period of strangulation, or early, even, when the stricture has been tight, the colour is of a deeper hue, and the vessels are distended with black blood. If the intestine is of a deep chocolate-colour, which does not diminish speedily on the division of the stricture, nor the blood pass from the distended veins, it is, even though it emit no offensive odour, on the verge of gangrene. When the intestine, instead of being tense and shining, has lost its polish, becomes flabby, exhibits phlyctenular elevations of the serous membrane, has an ash-coloured tint, and spreads an offensive odour, it is already gangrenous. If the parts covering the tumour are found before the operation crepitant, and spreading an offensive odour, gangrene has unquestionably taken place. This effusion of odour through the skin I have several times observed when called too late, or the patient had resisted a timely performance of the operation. In one case of crural hernia, in the visit to which I was accompanied by Professor Mussey, of Cincinnati, an extensive irregular gangrenous discoloration was observed, without apparent affection of the skin, resembling in appearance an extensive ecchymosis at the lower part of the abdomen. And more recently I have met with a similar case, which occurred in the practice of Dr. Janney, of this city, in which the integuments of the lower part of the abdomen and the upper part of the thigh had become completely sphacelated. In a case of strangulated congenital hernia occurring in a young gentleman, for which I operated with the advice and assistance of the late Dr. Parrish, thirty-six hours only after the first protrusion of the intestine, this odour was perceptible through the skin, and we found, on cutting down, seven inches of the small intestine in a state of almost diffuent gangrene. In most instances, however, in which we have the misfortune to meet with gangrene, it is limited to a small extent of surface; sometimes it is in the form of spots upon the prominent portion of the intestine, and especially in those cases where the attempt to reduce it by taxis has been made too roughly, or continued too long. Occasionally it is found in separate points round the part embraced in the neck of the sac—sometimes it is preceded by a small abscess developed in the thickness of the tunics; in either of these latter cases, in attempting, for the

purpose of dividing the stricture, to separate the adhesions which unite it to the neck, or in endeavouring to draw the intestine gently out after the division of the stricture, to examine its condition, the intestine may, without the greatest care is exercised, give way and discharge its contents.

2. *Appearance of the omentum.*—The characteristic appearances of gangrene in the omentum are neither so strongly marked nor so readily detected as those of the intestine. In the earliest stage we find the omentum gorged with blood, soft and puffy at points; when gangrene is fully formed the omentum is mottled with dark patches of ecchymosed blood, offensive, and presents grayish sloughs that may be drawn out in strings with the forceps.

It may, however, be observed, that strangulation of the omentum will be longer borne without its resulting in gangrene, and is therefore less frequently seen than that of the intestine. Death, notwithstanding, often follows as a consequence of strangulation either of intestine or omentum, even when it produces effects short of gangrene, in consequence of the inflammation of the peritoneum, to which it gives rise after the return of the viscus, or that of the great mass of the omentum, which is prone to run into abscess.

TREATMENT OF HERNIA.

1. *Of reducible hernia.*—The treatment of this description of

PLATE LVIII.—PROCESSES FOR THE RADICAL CURE OF REDUCIBLE HERNIA.

The object of these different processes is to obtain a radical cure of the hernia, by causing an adhesive inflammation of the walls of the sac, the viscera being previously reduced.

Fig. 1.—(A). *Process of M. Bonnet.*—This consists in enclosing the cord between two pins, the ends of the pins being fastened upon two hemispherical rolls of linen.

a. The rolls of linen, attached to the two ends of the upper pin which has been passed between the integuments and cord just below the level of the external ring.

b. The rolls of linen, for securing the ends of the lower pin which has been passed behind the cord.

(B). *Process of Gerdy.*—A fold of skin is pushed with the fore finger through the external inguinal ring into the inguinal canal. A curved needle has then been passed along the finger and carried through the double thickness of skin and the anterior wall of the canal which is found between them. This is the first step of the operation.

(C). In this drawing the operation of Gerdy is shown completed. The skin at the border of the opening made by tucking the fold of skin into the canal being united, as in a plastic operation, to a flap of skin which has been raised from below it.

Figs. 2, 3, 4, 5.—*Process of Belmas.*—The needle of this surgeon, seen at the bottom of the plate immediately below fig. 2, and at the two smaller figures at the right hand of the plate, is complicated in its structure. It consists of a canula, separable at the middle (*a*) into two portions (*b, b*), enclosing two fine stiletts (*c, c*), provided with a joint at *d*, which admits of a quarter turn being given to the movable end, so as to make it at will serve the purpose of a hook. The blade or head of the instrument (*e*) may be detached from the shaft (*c*).

Fig. 2.—*First stage of the operation.*—Puncture with the instrument through the hernial sac, which has been raised with a fold of the skin.

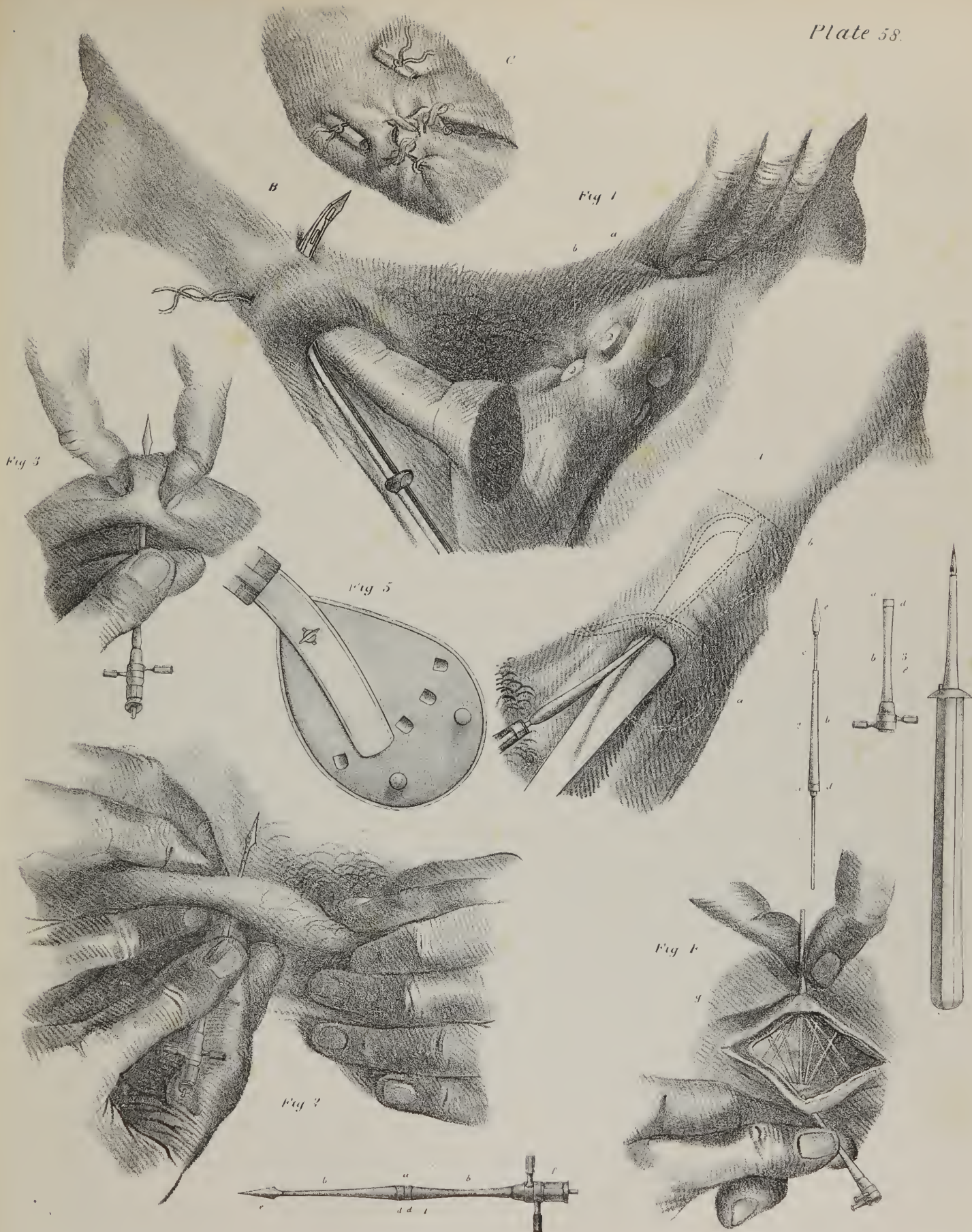
Fig. 3.—*Second stage.*—The surgeon now seizes the shaft of the instrument through the sac and skin, for the purpose of detaching the two portions of the instrument.

Fig. 4.—*Third stage.*—The sac is represented as laid open on the dead body, in order to show more clearly what is effected on the living in the interior of the sac. The interior shafts (*c, c*) being removed, the two ends of the canula are bent at *d, d*, so as to act the part of hooks, with which the sides of the hernial sac are separated in opposite directions. Through the passage in the handle (*f*) threads of gelatine (*g*) are to be introduced, and allowed to remain so that they may be dissolved and ultimately absorbed, after having produced the requisite adhesive inflammation.

Fig. 5.—*Elastic pad of Belmas*, attached to a truss for the purpose of making permanent compression upon the sac. The several holes seen in the plate, allow the spring to be attached so as to vary the angle, in proportion to the existing prominence of the abdomen.

Fig. 6.—*Process of Velpeau.*—In this operation the integuments are pushed into the canal, as in the process of Gerdy—a flat strip of wood (*a*) being used for the purpose instead of the finger. Upon this strip the cutting head of a large needle-shaped instrument is carried, which M. Velpeau pushes through the integuments and the wall of the sac, and employs to scarify the neck. The two transverse dotted lines indicate the places of the external and internal abdominal rings. The dotted lines between the rings indicate the track of the instruments under the skin.

Fig. 7.—The instrument employed by the author in the puncture of the sac. It consists of a stout acupuncture needle mounted on a gold canula; it is represented a third too large in the drawing. A small pin attaches the handle to the cup of the canula, so as to allow the instrument to be introduced by rotation, without the stilet turning in the canula. A small graduated syringe, for the purpose of throwing in the stimulating fluid, completes this simple apparatus.



hernia will consist merely of the application of a truss, for the purpose of palliating the pain and inconvenience of the affection by keeping the viscera from protruding after they have been returned into the cavity of the abdomen, or in the attempt to effect by specific means a radical cure. Of the application of the truss it is not necessary here to treat further than merely to observe, that in ordinary oblique inguinal hernia the pad or block of a spring truss should be applied over the track of the inguinal canal, so as to make pressure upon the internal ring; it is to be placed upon the external ring over the pubis, in cases of direct inguinal hernia, in the congenital hernia of infants, and in those instances of oblique inguinal, in which the internal ring has been dragged down to the level of the external.

Radical cure of hernia.

In favourable cases, and especially in young subjects, this may be effected by the long-continued application of a truss. When it has not been accomplished by this means, a variety of different processes have been resorted to, to effect it by operation. Many of those practised by the older surgeons—which it will suffice merely to enumerate—have for a long time been entirely abandoned; viz: *Castration*; *cauterization* upon the surface of the skin, or upon the neck of the sac after the skin had been laid open so as to expose the cavity; *ligature of the neck of the sac* with a gold thread (golden stitch) or an ordinary ligature—the *royal stitch*, which consisted in sewing up the neck of the sac, and excising all the body of the sac below the line of suture—the *Spanish process*, in which the sac was laid open for the purpose of pushing the testicle into the cavity of the abdomen, and closing the neck with the golden stitch; and the *reduction* of the hernial sac entire after having previously dissected it up from its attachments.

Various other methods have been resorted to by modern practitioners, but in *inguinal hernia almost exclusively*, some of which are entitled to more favourable consideration, though in regard to no one has perhaps a sufficient amount of experience been acquired to entitle it to particular recommendation.

1. *Acupuncture*.—This has been for the last fifteen or twenty years practised more or less in this country. It consists in making from the surface of the skin one or two rows of punctures with a common acupuncture or large sewing needle across the neck of the sac immediately below the orifice of the external ring. The author made repeated trials of this practice about twelve years ago, and though he found it insufficient of itself to effect a cure, in a few cases it appeared, by the irritation developed in the sac, to facilitate the obliteration of the passage by the action of the truss. The partial success obtained by this means, induced him, in conjunction with Dr. Young, of Tennessee, then a student of his, to resort to the more positive means of exciting inflammation by the instillation of a few drops of some highly stimulating fluid into the cavity of the sac.

2. *By injection*.—This process, as employed by the author, is as follows. The contents of the hernia must be completely returned into the cavity of the abdomen—for the process is only appropriate to cases of reducible hernia, and those which are not of large size. The apparatus required is a minute trocar and canula, (Pl. LVIII. fig. 7,) a small graduated syringe, capable of containing a drachm of fluid, well fitted to the end of the canula,

and a good-fitting truss for the purpose of making compression. The patient is to be placed on his back; the viscera are then to be reduced and the truss applied over the external ring for the purpose of keeping them up, as well as to prevent any possibility of the small quantity of fluid thrown in getting into the cavity of the abdomen. The surgeon then presses with the finger at the external ring so as to displace the cord inwards and bring the pulpy end of the finger on the spine of the pubis. At the outer side of the finger he now enters with a drilling motion the trocar and canula, till he feels the point strike the horizontal portion of the pubis just to the inner side of the spine of that bone. The point is next to be slightly retracted and turned upwards or downwards; the instrument is then to be further introduced till the point moves freely in all directions, showing it to be fairly lodged in the cavity of the sac. The point of the instrument should now be turned into the inguinal canal, for the purpose of scarifying freely the inner surface of the upper part of the sac, as well as that just below the internal ring. The trocar is now to be withdrawn, and the surgeon, again ascertaining that the canula has not been displaced from the cavity of the sac, throws in slowly and cautiously with the syringe, which should be held nearly vertical, half a drachm of Lugol's solution of iodine, half a drachm of the tincture of cantharides or some other stimulating fluid, which should be lodged at, or rather just below, the orifice of the external ring. The canula is now to be removed, and the operation is completed. A compress should be laid above the upper margin of the external ring, pressed down firmly with the finger, and the truss slid down upon it. The patient is to be kept from changing his position during the application of the truss, and should be confined for a week or ten days to his bed, with his thighs and thorax flexed, keeping up steadily as much pressure with the truss as can be borne without increasing the pain, in order to prevent the viscera from descending and breaking up the new adhesions while they are yet in the forming state, or avoiding the risk of their becoming strangulated or being rendered irreducible by the lymph effused into the cavity of the sac.

The author has practised this operation in thirteen different cases, in but one of which was there any peritoneal soreness developed that excited the slightest apprehension, and in this case it subsided under the application of leeches and fomentations. In several of these cases a single operation appeared to be perfectly successful. In others—where the sac was large, or the patient was less careful in keeping the truss steadily applied during the first week, or from a cautiousness in introducing in the first cases a more limited amount of fluid—the effect was merely to narrow the sac, rendering a repetition of the process necessary for the cure. Of the permanency of the cure, during *several years after the operation*, the author is unable to speak, most of the patients operated on being temporary residents of the Philadelphia Hospital, and passing after a few months beyond the reach of inquiry. While under the cognizance of the author, they were employed without a truss as labourers on the farm attached to the institution, and in no one of the cases, during this period, had the hernial tumour recurred. It would, however, be but a proper measure of precaution to direct the truss to be worn subsequently for several months, in order to confirm the cure.

The greater number of these operations were performed by the

author eleven years ago, before classes of students at the Philadelphia Hospital, but as he was able to trace the future history of the cases but for a few months only, they were not deemed of suffi-

cient importance for publication. Very recently M. Velpeau has published a process almost precisely the same as that just described.

PLATE LIX.—SURGICAL ANATOMY OF HERNIA.

(Figs. 1, 2.) OBLIQUE INGUINAL HERNIA IN THE MALE.

Fig. 2.—A dissection has been made, so as to exhibit the different coverings of the tumour.

- a, a.* Flaps of the skin and superficial fascia, reverted.
- b, b.* Aponeurotic tendon of the external oblique muscle, a portion of which has been excised over the track of the inguinal canal. The edge of it (*b, i*), forming the external abdominal ring, is left undisturbed, and is seen dividing, as it were, the tumour into two portions—one of which is lodged in the scrotum, and the other in the inguinal canal. The muscular fibres immediately below this, at the top of the inguinal canal, and which have been in part removed, belong to the internal oblique and transversalis muscles.
- c, c.* Cremaster muscle, a portion of which is removed in front of the tumour, and appears connected at the top with the origin of the internal oblique from Poupart's ligament.
- d, d.* Section of the covering of the hernia in the region of the scrotum.
- e, e.* Hernial sac, the front portion of which has been removed to bring into view the small intestine and the fold of the omentum (*f*) covering the intestine. Between the sac and the cremaster is another thin layer, which is the infundibular fascia from the internal ring. The intercolumnar fascia from the columns of the external ring has been removed. This, which is very thin, with the cremaster and the infundibular fascia, make the coat called the tunica vaginalis communis. Between the cut edge of the sac and the divided margin of the internal oblique and transversalis muscles, is seen a portion of the transversalis fascia forming the internal abdominal ring.
- h.* Epigastric artery and veins, the direction of which, towards the rectus muscle, is shown by the removal of the soft parts above it.

Fig. 1.—Interior of the same sac, after the removal of the viscera.

- g.* Femoral artery and vein.
- h, h.* Epigastric artery, showing the direction of this vessel between the two rings and behind the canal.
- i.* External abdominal ring, greatly dilated.
- k, k.* The upper of these references points to the internal abdominal ring; the lower to the inguinal canal, the length of which has been diminished by the lowering of the internal ring under the weight of the hernial protrusion.
- m.* Scrotal portion of the sac. The vessels, which are faintly seen lying behind the sac, belong to the spermatic cord.

(Figs. 3, 4.) CRURAL HERNIA IN THE FEMALE.

Fig. 3.—The covering of the hernial sac has been turned off in flaps. The crural canal is shown entire: the sac of the peritoneum, which has been pushed through it, has been opened merely at its superficial or subcutaneous portion.

- a, a.* Flaps of the skin and superficial fascia, turned off by a T incision.
- b.* Edge of Poupart's ligament.
- c.* Anterior portion of the sheath of the vessels.
- d, d.* Hernial sac, opened at the top and reverted upon the sides.
- e.* A knuckle of small intestine, and a portion of omentum, seen lodged in the crural ring.

Fig. 4.—Interior of the sac in crural hernia, shown without the intestine or omentum. To make this exhibition, it has been necessary, in consequence of the depth at which the passage is placed, to remove the fascia lata and all the front covering of the hernia.

- c.* Edge of the fascia lata, from which a portion has been removed.
- d.* Section of the sheath of the vessels.
- f.* Crural ring, through which the protrusion had taken place.
- g.* Pouch of the sac, formed in the sheath of the vessels.
- h.* Point where the hernial sac has been pushed out after it had dilated the orifice in the sheath of the vessels for the internal saphena vein.
- i, k.* Femoral artery and vein.
- l.* Internal saphena vein, surrounded by some lymphatic glands.

Fig 4

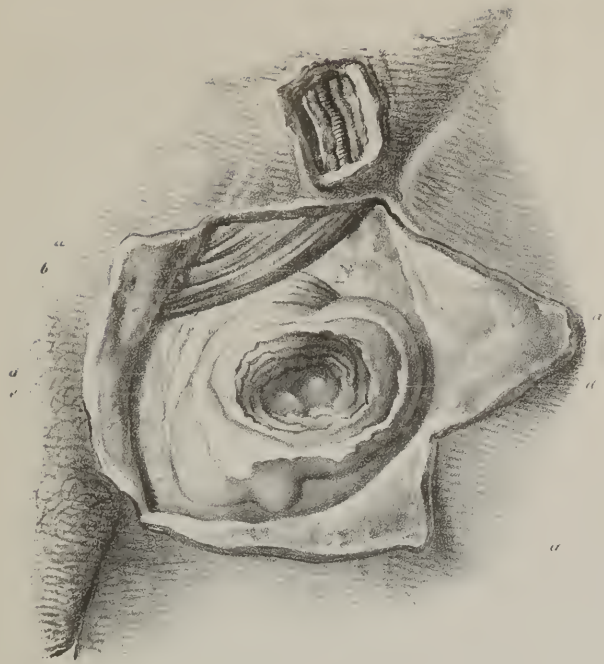


Fig 3

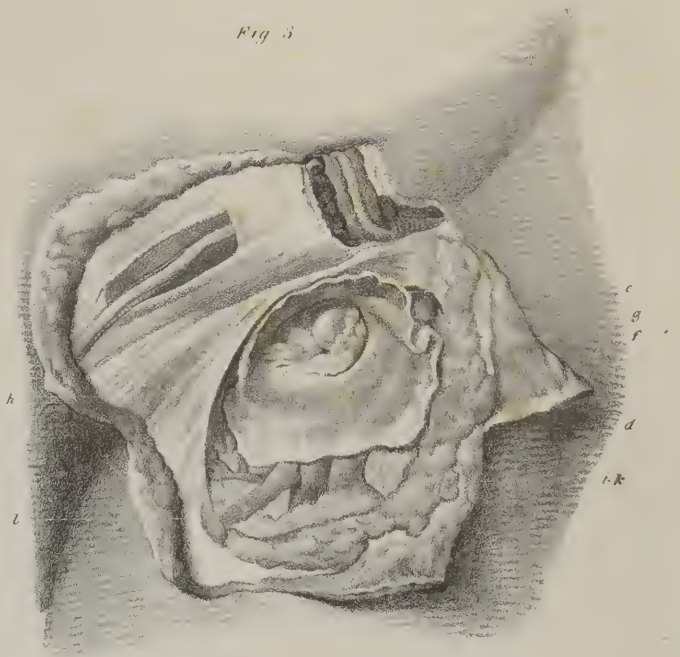


Fig 2

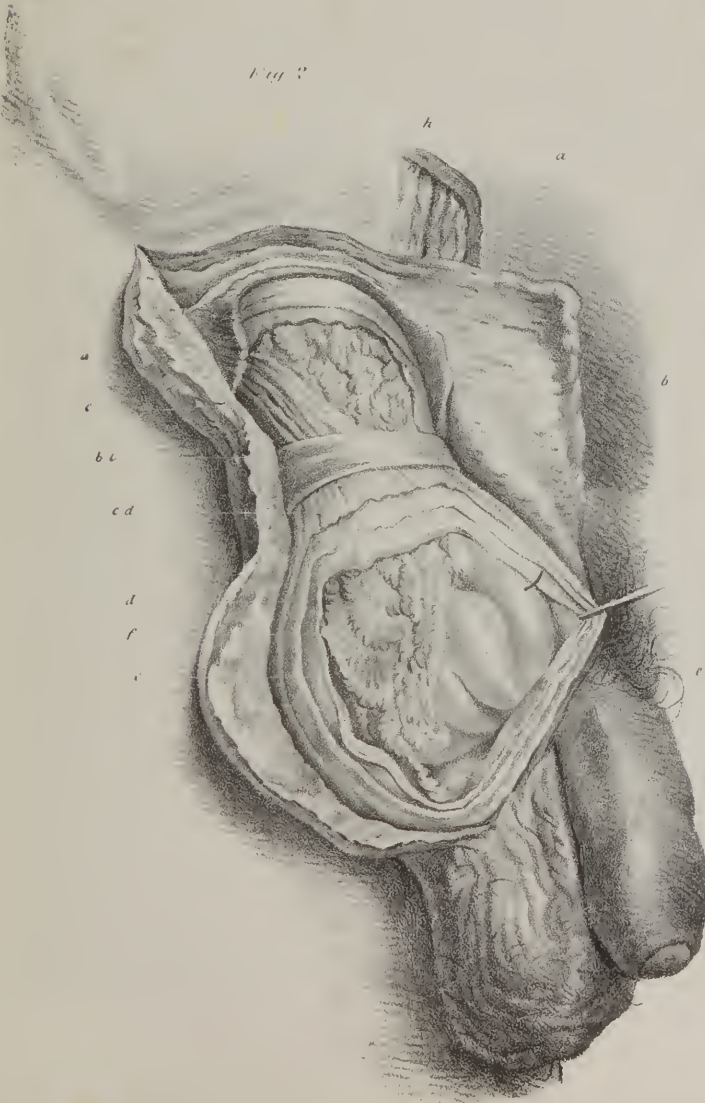
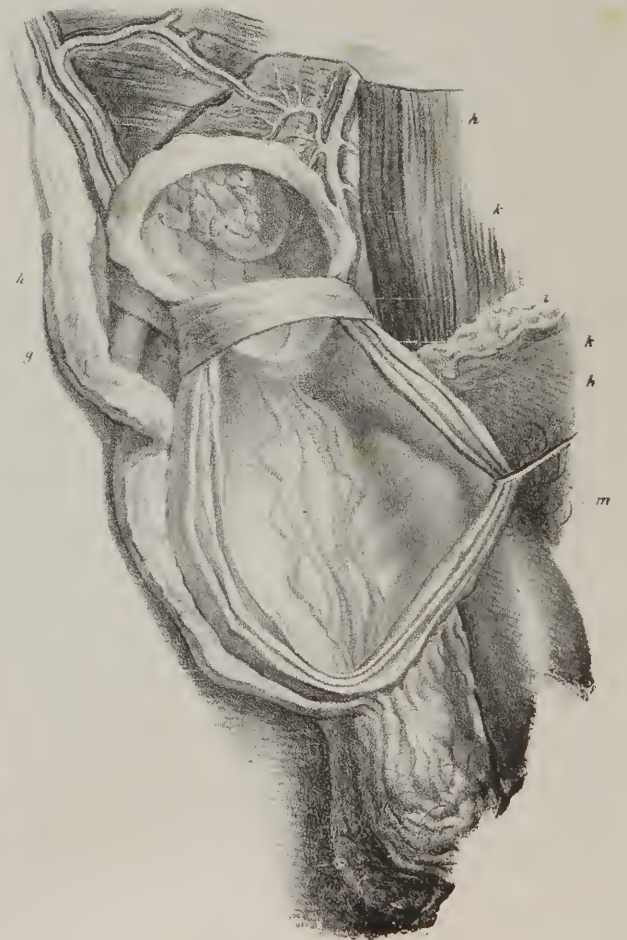


Fig 1



3. *Process of Bonnet.* (Pl. LVIII. fig. 1, A.)—Two to four ordinary pins an inch and a half long, and twice the number of hemispherical rolls of linen about the size of the end of the finger, constitute all the apparatus required. Each pin is to be pushed up to its head through one of these rolls of linen, so as to leave the rounded part of the latter presenting towards the point. The hernia is to be carefully reduced. The surgeon then grasps the integuments and the sac with the thumb and fore finger just below the external ring, so as to allow the cord to rise up in the circle formed by the grasp of these two digits, and passes a pin across below the envelops of the sac, entering it on the margin of the thumb nail near the suspensory ligament of the penis. The point which projects through the skin on the other side of the fold is to be passed through a second roll of linen, the convex edge of which looks towards the first. The two rolls are then pressed as tightly as possible towards each other, and the point of the pin twisted in a spiral form to keep them in place. The surgeon next grasps the integuments in the same manner just above the margin of the external ring, so as to press the cord down upon the first pin, and passes the second pin across *in front of the cord*, but parallel with the first. It is to be secured precisely as the first pin. It will seldom be found necessary to apply more than two pins. They give rise on the fourth day to considerable pain and soreness, and are to be withdrawn some time between the sixth and twelfth day, when sufficient inflammation has been excited, and the skin begins to ulcerate under the pressure. By this process the external ring, at the end of three or four weeks, is said to have been completely obliterated. M. Mayor, of Lausanne, has substituted double waxed threads for the pins, though without any particular advantage.

4. *Process of M. Gerdy.* (Pl. LVIII. fig. 1, B.)—The apparatus required in the process of this surgeon is a long curved needle with an eye near the point; some sections of quills, or a bougie, for three quilled sutures; a vial of concentrated ammonia, and six double ligatures. The surgeon pushes with the fore finger the skin at the top of the scrotum through the external ring into the inguinal canal, but in front of the spermatic cord. The long needle charged with a double thread is carried along the finger up to the top of the cul-de-sac, and passed through so as to come out upon the abdominal surface of the skin, traversing the two thicknesses of skin and the anterior wall of the inguinal canal which is included between them. One end of the double ligature is now drawn out from the eye of the needle and secured. The needle is then retracted from the wound, and passed a second time through the tissue by a new puncture, so as to come out at a place about half an inch distant from the first, carrying with it the other end of the double thread, which is now to be detached from the eye. The needle is then finally withdrawn. The inverted fold of skin is now kept in the canal by the loop of ligature just passed, which is to be secured (as shown in the drawing), over the barrels of a couple of quills, as in the ordinary quilled suture. Two other quilled sutures are applied in like manner—one at the internal and one at the external side of the first, but at the distance at least of half an inch apart. The cuticle of the inverted skin is now to be destroyed by reiterated applications of a pledget steeped in caustic ammonia, with the object of causing the opposite surfaces of the pouch to suppurate, and

unite by granulation. The skin may now be excised from the margin of the cul-de-sac, and a flap of integument raised from the neighbouring parts, fastened by suture over the base of the cavity as shown in the drawing. The sutures are to be removed between the sixth and eighth days.

5. *Process of Dr. Jameson, of Baltimore.*—This gentleman reports an instance of success in a case of crural hernia, in which he laid open the sac, and inserted into the orifice of the crural ring a flap of integument raised from the surrounding parts, and which was kept in position by the suture with which the external wound was closed.

This plan of plugging up the outlet of a hernial tumour with a portion of skin, which if it becomes adherent, must be converted into a species of cellular tissue, cannot possibly be very efficacious; for almost every surgeon must have been convinced by experience, that even a large mass of inflamed and adherent omentum left in the cavity of the sac, after the operation for strangulated hernia, is but seldom found to prevent the re-development of the hernial tumour.

6. *Scarification. Process of Velpeau.* (Pl. LVIII. fig. 6.)—The old process of scarification has been revived by this surgeon. The mode of its performance will be well understood by reference to the drawing.

7. *Process of M. Belmas.* (Pl. LVIII. figs. 2, 3, 4, 5.)—The process of this surgeon, as last modified, consists in the introduction into the cavity of the sac, as near as possible to the external ring, of narrow strips of gelatine, which are to be left in the sac for the purpose of exciting inflammation. They are said subsequently to dissolve and disappear by absorption. The mode of performing the operation is fully explained in the reference to the plate. It is not, however, believed to offer so fair a prospect of success as the process of M. Gerdy.

OF PARTICULAR FORMS OF HERNIA.

INGUINAL HERNIA.

There are two forms of inguinal hernia, which have been distinguished as the oblique and direct; the former of these is by far most frequently observed.

Surgical anatomy.—In oblique inguinal hernia, the displaced parts escape by the passage called the inguinal canal, while this as yet nearly preserves its normal form, and its proper anatomical relations with the surrounding parts; but when it has been long subjected to the weight and bulk of the hernial tumour, certain modifications of its structure are made, which it is absolutely necessary should be well understood by the surgeon. It will be proper, therefore, to study the healthy structure of the canal, as well as to note the changes produced in it by the long-continued action of the hernial protrusion.

Of the inguinal canal of the male.—This canal is *from an inch and a half to two inches long, and transmits* the spermatic cord. It pierces the abdominal walls in an oblique direction from above downward and inward. The upper orifice or commencement of the passage is found on the inner face of the parietes, nearly at the middle point of a line, drawn from the anterior superior spinous process of the ilium to the spine of the pubis. The termi-

nation or inferior orifice of the canal is found immediately below the integuments at the outer side of the body of the pubis. The wall of the abdomen through which this oblique canal runs, is at this point somewhat complicated in its structure. The boundary line between the abdomen and the top of the thigh consists of a strong fibrous cord, known as Poupart's ligament or the crural arch,* which is tensely stretched between the anterior superior spine of the ilium and the spine of the pubic bone. A portion of the upper surface of this arch is grooved so as to form the floor or inferior portion of the inguinal canal. The internal lateral boundary of this inguinal region may be considered as formed by the rectus muscle of the same side, which is extended in the middle line between the pubis and the sternum. Between the outer edge of the rectus muscle and the obliquely placed ligament of Poupart, is the proper inguinal region, which is of a triangular form with the apex at the outer side of the body of the pubis and the base opening upwards and outwards. This space is closed by the inferior portions of the three broad abdominal muscles, and the transversalis fascia. The aponeurotic tendon of the great oblique muscle as it descends downwards and inwards, is connected with the whole length of Poupart's ligament. As the sheet of tendon approaches the pubis, it splits so as to leave an elliptical or rather ovoidal opening—the larger end of the ovoid being formed by the body of the pubis, and its two sides by the margins of the tendon forming the split. The space formed by this split, though having the ovoidal shape as above mentioned, is the external abdominal ring. The margins of the split constitute the pillars or columns of the ring, the inferior one of which terminates upon the spine and crest of the pubis in close conjunction with the proper fibres of Poupart's ligament, and the superior or internal crosses over the symphysis so as to decussate with its fellow of the opposite side. The outer and upper extremity of the ring is crossed by the intercolumnar fibres, which are affixed in front of the aponeurosis, and have for their object the strengthening of the bond of union between the columns, so as to keep them from diverging and enlarging the ring. The inner termination of the aponeurotic tendon of the external oblique muscle is upon the linea alba, where it meets the corresponding muscle of the other side. But for the existence of the ring formed by this split of the aponeurosis, there would have been no opening by which the spermatic cord could have passed in its rout to the scrotum. On turning down this aponeurosis, we find immediately below it the lower edge of the internal oblique and transversalis muscles. These, besides their more extensive origin from the sides of the abdomen, arise in part from Poupart's ligament, and have the same general insertion into the linea alba and the spine and crest of the pubis. If they had taken their origin from the whole length of Poupart's ligament, the cord could not have escaped except by a split in their muscular fibres, which, if such had been the case, would have been likely by their contraction to have impaired the function of the cord. Such a result is obviated by the fibres of these muscles taking their rise from the outer half of the ligament, and passing round in an arch which is

concave downwards, so as to leave a passage for the cord between their concave edge and the ligament of Poupart below. The arches of the two are muscular where they cross in front of the cord in the space between the rings, but soon afterwards they form a common or conjoined tendon, which curves round to be inserted upon the spine and crest of the pubis, under the lower end of the inguinal canal and behind the external abdominal ring. This peculiar arrangement of the muscles appears admirably adapted for the purpose of preventing under ordinary circumstances the occurrence of hernia at this region, the fleshy belly of the arch resting over and in front of the internal abdominal ring, and the conjoined tendon giving strength to the wall behind the external ring. On removing these muscles, we have next brought into view the transversalis fascia which lines the inner surface of the muscle of that name, and runs down to be continuous with the whole inner border of Poupart's ligament. On the front of this membrane lies the spermatic cord in the whole length of the inguinal canal. The internal ring by which the cord gets from the abdomen into the canal, consists of an opening in this membrane of a semilunar shape, which is concave at its inner side. On this concave edge, sometimes called the internal pillar of this ring, which is sharp, resisting, and in some instances becomes the seat of stricture, rests the cord as it enters the canal. This ring, in the healthy state of the parts, is closed behind by the peritoneum. If now we turn down the fascia transversalis, we find the peritoneum everywhere behind it—a layer of cellular tissue merely separating the two, in which the different constituents of the cord run. The epigastric artery, which comes off from the femoral, runs up also in a direction nearly vertical through this cellular tissue behind the transversalis fascia, crossing behind the inguinal canal and between the rings, but rather nearer to the internal than to the external. In this cellular layer may also be observed the umbilical ligament, the remains of the umbilical artery of the fœtus. As the epigastric artery crosses between the rings in its ascent to the rectus muscle, it raises the peritoneum in a fold. On either side of this fold there is a fossa; the outer one of the two fossæ is opposite to the orifice of the internal ring; and the inner immediately behind the external ring, but separated from it by the conjoined tendon of the internal oblique and transversalis muscles.

These *inguinal fossæ*, as they are called, are only obvious when a flap of the abdominal wall is turned down. Through the outer one of these, pushing the peritoneal lining before it, passes the intestine or omentum in proper oblique inguinal hernia. Through the internal one, which is found between the epigastric artery and the umbilical ligament, the organs escape in that variety called direct or ventro-inguinal hernia, from the rout traversed being direct, and not oblique, like the passage of the proper inguinal canal.

The inguinal canal, which lodges the spermatic cord, has then, as will be seen from the above brief description, for its floor the groove in the upper part of Poupart's ligament; for its anterior boundary, the aponeurotic tendon of the external oblique; for its posterior, the transversalis fascia; and is in addition, at its upper part, overhung or overlapped by the fleshy edges of the internal oblique and transversalis muscles. The internal ring, the edges of these muscles, and the upper column of the external ring, as

* For the sake of greater clearness in the anatomical description of the parts, which must necessarily be brief, Poupart's ligament is represented as a separate cord, and not as it is usually considered, merely the lower edge of the aponeurotic tendon of the external oblique muscle.

well as the thickened and plaited neck of the sac, are the points which may become the seat of strictures in oblique inguinal hernia. If we examine the cord, we shall find that as it passes through the canal, it gets several coverings—1st, from the internal ring, a tubular or funnel-shaped prolongation of cellular tissue, (called *infundibular fascia* or *fascia propria*,) which follows it down to the scrotum; 2, from the edge of the internal oblique, a covering of muscular fibres (the cremaster) which passes down on the outer face of the last, and surrounds the testicle; 3, a cellular fascia similar to the first, extended downwards from the column of the external ring, over the face of the cremaster, and called the intercolumar fascia. These three coverings are intimately connected together, and though susceptible of separation in the healthy state and in recent hernia, are nevertheless in old cases matted together, and known then under the name of *tunica vaginalis communis*. After the cord leaves the external abdominal ring, it is, in addition to these parts, covered with the ordinary superficial fascia which extends down with it into the scrotum; where the fascia is modified in its structure and takes the name of dartos muscle. The hernial tumour is usually found on the front and outer side of the cord. The epigastric artery will be found at the inner side of the neck of the sac.

In *direct inguinal hernia*, or, as it is sometimes called, ventro-inguinal hernia, the protrusion takes place directly behind the external ring, and pushes before it the peritoneum, transversalis fascia and conjoined tendon, through the orifice of the external ring. The resistance made by the conjoined tendon is so great, that this form of hernia rarely attains much bulk, except, as now and then happens, when the viscera slip under the concave edge of the tendon, and pass out at the external ring. The coverings of this form of hernia will then be, with the exception of the infundibular fascia, nearly the same as in the oblique inguinal. The hernial tumour usually descends on the front and inner side of the cord. In this form of hernia, the epigastric artery will of course be found to the outer side of the neck of the sac.

The *inguinal canal in the fœtus* lodges, till near the seventh month of intra-uterine life, nothing but the fibrous structure, called the *gubernaculum testis*, provided for the purpose of drawing down the testicle, which, prior to this period, is lodged in the abdomen below the kidney, and covered in front by the peritoneum. Toward the period of birth, the testicle is gradually drawn down through the canal into the scrotum, bringing with it a process of the peritoneum; so that when this change has taken place, the canal contains all the parts common to the adult, with a cylindrical prolongation of the peritoneum in addition. The cavity of the peritoneum at the external ring is usually found closed at birth; and the tubular process extending to the testicle is ordinarily completely obliterated during the first month after birth—the fibrous structure of the gubernaculum becoming, as shown by Mr. Curling, the cremaster muscle. When the closure of the tubular passage does not take place by the adhesion of the peritoneal surfaces and the conversion of the membrane into cellular tissue, the vaginal pouch of the testicle communicates by a free passage with the cavity of the abdomen, through which a hernial protrusion may take place, the viscera passing down into the vaginal tunic of the scrotum, and lying in immediate contact with the testicle. As this passage has naturally a tendency to become

obliterated, the application of a truss is almost always successful in accomplishing its closure, even when a hernia has descended in the child so as to have been the means of keeping the canal patent.

STRANGULATED INGUINAL HERNIA.

When the hernial tumour becomes strangulated, it is attended not only with suffering of more or less severity, but with great and immediate danger, and calls for prompt and decided measures of relief on the part of the surgeon. These consist, 1st, in an attempt to reduce the protruded viscera by a process called the *taxis*; and 2d, in an operation for the division of the part which is the cause of strangulation.

1. *Of reduction by the taxis*.—The first object of the surgeon is of course, when practicable, to effect reduction without resorting to the use of the knife. The manipulation by the taxis has been briefly described as follows by Professor Syne.*

“The patient should be laid reclining, with his shoulders and pelvis slightly elevated, to relax the parietes of the abdomen; and with the same intention, the thigh of the affected side should be bent upwards and inwards, as the *fascia lata* is thus prevented from causing any tension of the abdominal fasciæ to which it is connected. The hernial tumour is then to be grasped at its neck, and compressed with the points of the finger and thumb, which at the same time pull it slightly outwards. The size of the parts at the ring having been thus diminished, the pressure is to be directed gently but steadily upwards, in the direction of the inguinal canal. When, in consequence of this proceeding, the slightest gurgle is heard or felt, or the size of the swelling is perceptibly diminished, the reduction, in general, may be very soon completed. The larger the hernia is, the more may be expected from this manipulation, and *vice versa*. There is almost always some serous effusion into the cavity of the sac, and in small tumours, especially those of recent production with acute symptoms, the bulk of the fluid bears a large proportion to that of the intestine or omentum. External pressure, consequently, however carefully employed, cannot possibly have its effect confined to the neck or any other portion of the strangulated parts, since, through the medium of the fluid, its force must be diffused over the whole surface, and therefore urge the entire mass against the narrow aperture by which it is required to return. While circumstances are thus opposed to the beneficial influence of pressure from without, it is obvious that the small size of the protrusion, which is often not larger than the point of the finger, and seldom exceeds that of a walnut in most cases, will afford little resistance to an effort in the opposite direction. It accordingly often happens that after the taxis has failed, the tumour suddenly, and, as it seems, spontaneously disappears, no doubt through the operation of some internal change in the condition of the bowels or omentum.

“Such being the case, in the event of the taxis failing, it is obviously proper to use means that may produce some effect of the kind requisite for *withdrawing* the protruded parts into the abdominal cavity. Of these may be mentioned a change of posture, by elevating the pelvis and bending the shoulders back-

* Principles of Surgery, London, 1842, pp. 312-314.

wards, in order to make a drag on the strangulated viscera—the administration of enemata to evacuate the intestines, and thus lessen the resistance to return—bleeding largely to diminish the contractile tone of the muscular fibres—using the warm bath with the same view—and in addition to it also employing opium or tobacco. The application of cold externally, and the internal use of tartrate of antimony, or purgatives, are means occasionally resorted to, but with more questionable advantage.

“The choice of means for the purpose of promoting reduction must be determined by the circumstances of the case. When the patient is strong or plethoric, it will always be right, in the first instance, to abstract a considerable quantity of blood. Repeated injections, or the warm bath, if it can be procured, should also be constantly employed. In regard to tobacco it is necessary to be cautious, lest too great depression be induced by its use, so as to render the patient unable to bear an operation in the event of this measure proving necessary. The safest plan is to inject ten or twelve grains infused in an English pint of water, and repeat this if it seems requisite. The bowels having been thus, if possible, unloaded, and the spasmodic tension of the abdominal muscles, which is caused by the irritation of the disease, and reacts injuriously upon it by tightening the fasciæ which produce the stricture, having been subdued or diminished, the taxis is again to be tried. If a patient and careful trial of it should fail in the more favourable circumstances that now exist, the surgeon must think of removing the resistance by dividing the stricture with the knife. It is difficult to determine how long the operation may be safely deferred, as inflammation and gangrene supervene much more quickly in some cases than in others. The best course is to operate so soon as a fair trial has been given without success to the taxis, and the measures which promote it, especially bleeding, and the warm bath if it can be procured. It should be recollected, 1. That the danger of the operation itself is very inconsiderable; and that consequently, the patient should not, for fear of incurring it, be subjected to the greater risk, or rather almost certainty, of a fatal issue, which attends the disease when allowed to follow in its course. 2. That the progress of the bad consequences is usually rapid, in proportion as the hernia is small, recent, and tense. 3. That in small recent hernias there is least advantage to be expected from waiting. 4. That in large hernias, strangulated in consequence of congestion, there is most assistance to be looked for from the continued use of purgatives and injections. 5. That the operation is attended with least danger in cases where the tumour is small and recent; and with most where it is large and of old standing.”

Operation for Inguinal Hernia.

In the operation for strangulated inguinal hernia, the patient is to be placed on the right side of his bed, with his chest and thighs elevated, or as is more commonly preferred by English and American surgeons, on the foot or side of the bed, with his thighs flexed, and his feet resting upon a couple of stools—the surgeon taking his position between the limbs of the patient. The operation is divided into five periods:—1. The incision of the skin. 2. That of the layers between the skin and the sac. 3. The opening of the sac. 4. The division of the stricture; and 5. The reduction of the protruded viscera. Whether the opera-

tion be for the oblique, direct, or congenital form of inguinal hernia, it will correspond in so many respects with that given below for the first of these varieties, that the modifications requisite will, from what has been already said in reference to each form of the affection, be readily understood without a special description.

1. *Incision of the skin.*—The parts are, if they require it, to be carefully shaved. The incision may be made through the skin, over the axis of the tumour, from above downwards, or by raising a fold and dividing it from within outwards, as directed at page 12. The incision should always commence three-quarters of an inch at least above the top of the tumour, in order that we may expose clearly the opening of the canal. If the hernia is one of the interstitial class, that is, confined to the canal, it should extend also for about the same distance below the external ring; if scrotal, it should at least be from three to four inches in length.

2. *Incision of the layers between the skin and the sac.*—This part of the operation is to be executed with particular care. These layers, if the surgeon is sure of his hand, may be divided from above downwards with light strokes of the knife. But as a general rule,* it will be found safer and more expeditious to raise up with the forceps the distinct tunics one by one at the lower end of the line of incision, open them by a horizontal puncture with the knife, through the opening thus made introduce a grooved director, and on this slit them up one after another the whole length of the external wound, until the surface of the sac and the tendon of the external oblique muscle above the ring become fully exposed. The arteria ad cutem abdominis and some branches of the external pudic vessels, will be divided in the section of the superficial fascia, and may require to be tied. The mode of proceeding will now vary according as the hernia is interstitial—confined between the two rings—or inguino-scrotal, extending through the canal into the scrotum, which is the form most commonly met with in practice. In the interstitial variety, the tendon of the external oblique is to be divided on the director, which is to be introduced upwards from the external ring, or if found more convenient, from above downwards through a puncture made at the top of the wound. This lays bare the sac for opening, which will be seen crossed by some of the fibres of the internal oblique and transversalis muscles, and covered by the thin infundibular fascia. In inguino-scrotal hernia, the sac may be at once opened up to the external ring, the necessity of any division of the aponeurosis of the external oblique being subsequently determined by the point at which the stricture is found.

3. *Opening of the sac.*—In very many instances this will be found so adherent to the coverings on its outer face, that it must be raised up with them and divided on the director. The author has very frequently, when the general coverings of the hernia have been thin and adherent together, and especially in operations for inguinal hernia in the female, after the section of the skin, penetrated at once by a cautious horizontal cut of a fold raised by the forceps into the cavity of the sac, and by intro-

* It has already been observed, that from the agglutination of parts, produced by the effect of pressure on the coverings of the hernia, the number of distinct separable layers will vary in different cases of hernia—the infundibular fascia, the cremaster muscle, and the intercolumnar fascia, usually forming one coat in old herniæ, called the tunica vaginalis communis.

ducing the director and lifting the parts well upwards so as to see that none of the viscera were raised, slit up all the remaining coats of the tumour at one stroke with the knife. But as a general rule, the surgeon must proceed cautiously and leave the sac as a last covering to be separately opened. This must especially be the practice in case the subcutaneous layers are found loaded with fat, contain enlarged or suppurating lymphatic glands, cysts resulting from an old hernial tumour, or any of the various complications which may occur at this region. Sometimes the mass of subcutaneous fat may be so great and so deeply placed as to cause a suspicion that it might be formed by the omentum, which had become prominent in consequence of a breach in the sac itself. Under such circumstances, the surgeon is to tear through a portion of its structure with the point of the director, for the purpose of determining with certainty the character of the parts which lie immediately behind it. In some rare instances, especially in direct inguinal hernia, the cord has been found pushed in front of the sac, and occasionally even with its different constituents spread out in the form of a sheet. In all instances, therefore, where anomalous appearances present, the surgeon is to proceed with especial caution, raising every separate layer on the director, and examining it with the eye and by the touch before applying the knife, in order to avoid the risk of injury to the protruded viscera, or the wounding of the spermatic arteries or duct.

The sac, when exposed on its outer surface, will be recognized by its smooth and shining appearance and the dark colour of the bowel seen through it, and will usually in this form of hernia be found to contain a considerable quantity of serum. If the case be one of congenital hernia, the sac is formed by the tunica vaginalis, and the fluid will be found collected in a cavity analogous to that of an ordinary hydrocele. The sac, if thin and yielding, may be opened as practised by Dr. Hartshorne of this city, by embracing the back part of the tumour with the fingers of the two hands, and lacerating it in front by pressure in opposite directions with the ends of the thumbs. In ordinary cases it answers best to elevate a fold with the forceps or the thumb and finger, and open it by a puncture as directed for the other coverings. The opening should be made a little to the outer part of the axis of the tumour—and the membrane divided on the director upwards to the ring, and downwards sufficiently far to expose the contents of the tumour and prevent the formation of a pouch for the lodgment of pus. On the division of the sac, the bulk of the intestine rises up and appears greatly increased in volume. The protruded parts are now to be carefully examined. If they are united by soft and recent adhesions, the union may be broken with the finger; if by firmer filaments of old formation, divided with a pair of scissors: but if the viscera are rendered adherent to the sac by broad firm bands of attachment, the surgeon is to proceed, without disturbing them, to the next step, which is that of determining the seat of strangulation. To effect this he is to draw, if possible, gently outwards all the intestine lodged in the inguinal canal; but in doing this the greatest care must be exercised to employ only the slightest degree of traction, for fear of lacerating the bowel and causing an effusion of its contents, especially if the strangulation has been such as to be likely to have caused softening or gangrene. If the parts yield to the effort, but go back again with a slight elastic rebound, the stricture is seated at the neck of the sac.

If this does not take place, and the external ring is free, the stricture will be almost always found at the internal ring, it being but in rare instances formed by the edge of the internal oblique and transversalis muscles. If the stricture is at the external ring, which may be ascertained by the examination of that orifice with the finger nail, the bowel cannot be drawn out without a previous division of the ring. If, as sometimes happens, the strangulation is made by an accidental band of adhesion in the cavity of the sac, this becomes obvious in unfolding the part. If the viscera are free in the sac, the left fore finger with its back towards them, should be carried up under the front wall of the sac, for the purpose of ascertaining the precise seat of strangulation, and the end of the finger, or at least the nail, insinuated under the stricture.

4. *Division of the stricture.*—We now pass up, laying it flat on the palmar surface of the finger, a probe-pointed bistoury, which should be wrapped with a waxed thread, or a strip of adhesive plaster, to within half an inch of the point; or, which is preferable, use the probe-pointed hernia bistoury of Sir A. Cooper, as this has a cutting edge of but little more than half an inch in length. The probe point of the instrument is then to be insinuated under the stricturing band, and the instrument turned with its edge directly upwards, as shown at Plate L. fig. 2. The surgeon now, partly by rocking the point of the bistoury upwards and partly by pressing with the finger, nicks the resisting parts. As the border gives way, it allows the finger to be more freely introduced, over which the orifice may then be safely enlarged to the requisite extent with the instrument. If the stricture is at the neck of the sac, and to the inner side of the internal ring, it should, as directed by Sir A. Cooper, in order to render its division with the knife more safe, be drawn somewhat down by an assistant, who for that purpose grasps the opened sides of the sac with a couple of pairs of forceps—another assistant at the same time raising the abdominal wall at the top of the incision.

If the stricture is at the internal ring or the neck of the sac, and so narrow that neither the finger, which has to be passed under the anterior wall of the canal to reach it, nor the finger nail can be got between it and the bowel, more difficulty will attend its division. It is not advisable in scrotal hernia to slit upwards the orifice of the external ring for the purpose of exposing the deeper-seated parts, as this would increase greatly the difficulty of retaining the hernia in place after reduction, when it is otherwise possible to accomplish the division safely. It may, however, occasionally be found necessary to enlarge the external ring even when it is not the seat of stricture, so as to admit the free examination of the part at the neck of the sac. In these cases of extreme tightness, it has been recommended to introduce a grooved director below the stricture, and divide the band with a probe-pointed bistoury passed along the groove. This cannot, however, be safely done in parts that are not exposed to view, as the intestine may bulge up and come in contact with the edge of the knife. The author prefers greatly in these cases, first to carry up the finger to the point of stricture, then slide over the finger the common spatula of the dressing-case, which is to be insinuated between the intestine and the stricturing band. The protruded intestine should now be held down by an assistant, and the handle of the spatula will sufficiently protect the intestine to admit the

introduction of the probe-pointed bistoury for the purpose of dividing the stricture. But in case the stricture is at the top of a long canal, the operation, even with this precaution, would be attended with risk of injury to the bowel, and it might become necessary to incise the whole length of the anterior wall of the canal on a director. The division of the stricture, at whatever point it is found, is always to be made in this form of hernia directly upwards, as directed by Sir A. Cooper, as this gives sufficient space for the return of the viscera, does not endanger the cord, and is in a course nearly parallel with the epigastric artery—of the relative position of which vessel to the stricture we cannot, as has before been mentioned, be always positively certain. An incision of the stricture that will allow the finger to move freely in the passage, answers for the return of the protruded parts when they are not unusually bulky. An incision of the

stricture for the sixth or the fourth of an inch in extent will usually suffice for this object. If greater space be required, it is considered safer, on account of the oblique course of the epigastric artery, to gain it by two, three, or more separate small incisions on the outer and inner margins of the stricturing band.

5. *Reduction of the viscera.*—It now remains to examine the condition of each viscus at the strictured point, and return it, if found in a suitable condition, into the cavity of the abdomen. For this purpose, if it is a case of entero-epiplocele, the omentum is to be turned off and the intestine gently drawn down. This enables us not only to examine the intestine at the point at which it is most liable to have suffered, but to diminish the tension at the protruded part by giving greater space for the diffusion of its contents, and thus facilitate the process of reduction. If the viscera admit of being at once reduced, the intestine is to be

PLATE LX.—OPERATIONS FOR STRANGULATED HERNIA.

(Figs. 1, 2.) STRANGULATED OBLIQUE INGUINAL HERNIA.

Fig. 1.—Opening of the sac.—The integument, superficial fascia, and tunica vaginalis communis, are laid open so as to expose the sac covering the protruded viscera, and a portion of the tendon of the external oblique muscle. At the period of the operation shown, the surgeon lifts a fold of the peritoneal sac from off the surface of the intestine, and punctures it with the knife held flatwise.

Fig. 2.—Division of the stricture.—The sac has been opened its whole length on the director, and the point of the fore finger passed over the fold of the bowel, is insinuated under the edge of the external ring. Over the pulpy surface of the finger (*a*) is passed the back of the ordinary probe-pointed bistoury (*b*), for the purpose of dividing the stricture which is here supposed to be at the external abdominal ring. If the stricture is seated at the internal ring, or at the neck of the sac, the process for its division is the same, except that the hernia bistoury of Cooper (*D*) should be employed. But if the ordinary probe-pointed bistoury is used in place of that of Cooper, it should be wrapped down to near its end with a waxed thread or a strip of adhesive plaster.

(Figs. 3, 4, 5.) STRANGULATED CRURAL HERNIA.

Fig. 3.—Opening of the sac.—The integument and superficial fascia have been opened by a Γ incision. The sac has been incised so as to expose the fold of intestine and omentum. The opening in the sheath of the vessels (*a, a*), which is here supposed to be the seat of stricture, has been dilated with the probe-pointed bistoury over the end of the finger, in order to relieve the strangulation. The lower end of the peritoneal pouch is shown on the point of being laid open with the bistoury (*b*) over the finger (*c*), so as to leave no cul-de-sac for the retention of the secretions during the cure.

Figs. 4, 5.—Division of the stricture by different processes, when the strangulation takes place at the ligament of Gimbernat, Hey's ligament, or the neck of the sac.

Fig. 4.—e. Division of the edge of Gimbernat's ligament, Hey's ligament, the inner edge of the sheath of the vessels, or the neck of the sac, in the usual direction, upwards and inwards toward the umbilicus. The end of the finger (with its back surface toward the contents of the tumour), is inserted carefully under the edge of the stricture, and along this is slid flatwise the probe-pointed bistoury of Cooper. As soon as the bistoury has passed below the stricture, its edge is turned upwards and inwards for the purpose of dividing it.

f. Process of Pott for dividing with his curved bistoury the inner end of the crural arch directly upwards.

g. Process of Sharp for its division obliquely upwards and outwards. This is attended with risk of cutting the femoral vein.

Fig. 5.—h. Process of Sabatier for the division of the stricture upwards and inwards.

i. Process of Dupuytren for dividing the ligament of Gimbernat obliquely upwards and outwards, by an incision from the exterior with a convex bistoury.

k. Process for dividing the stricture on a grooved director, which is to be entered by an incision through the upper part of Gimbernat's ligament, and brought out through the orifice of the crural ring.

l, l, l. Several small incisions, as in the process of Scarpa, for enlarging the orifice of the crural ring.

Fig 1

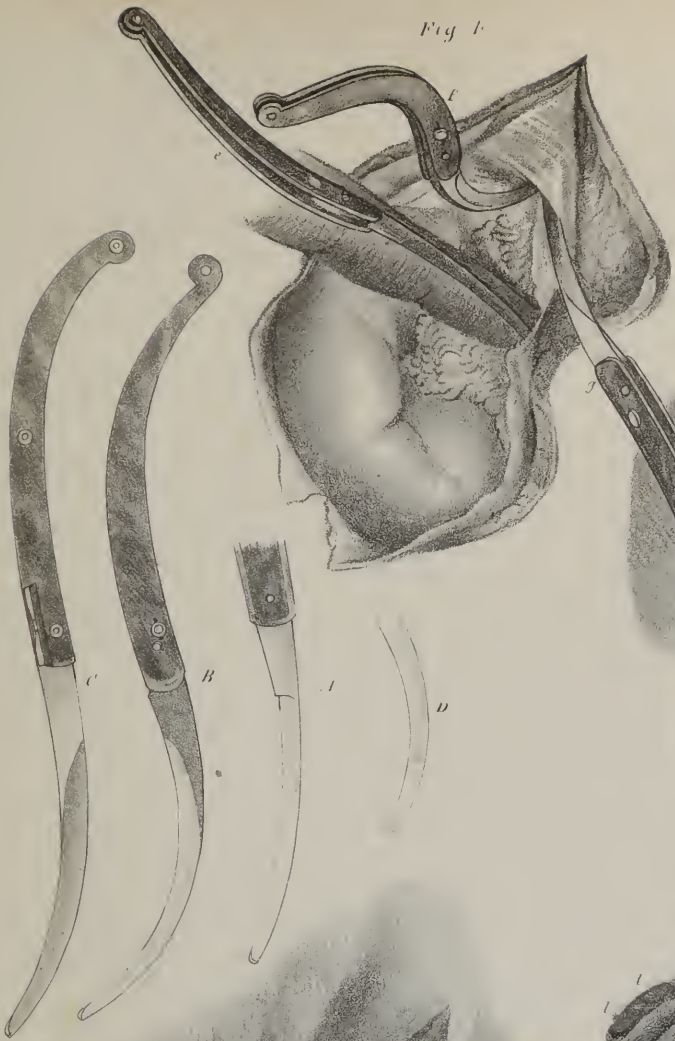


Fig 2

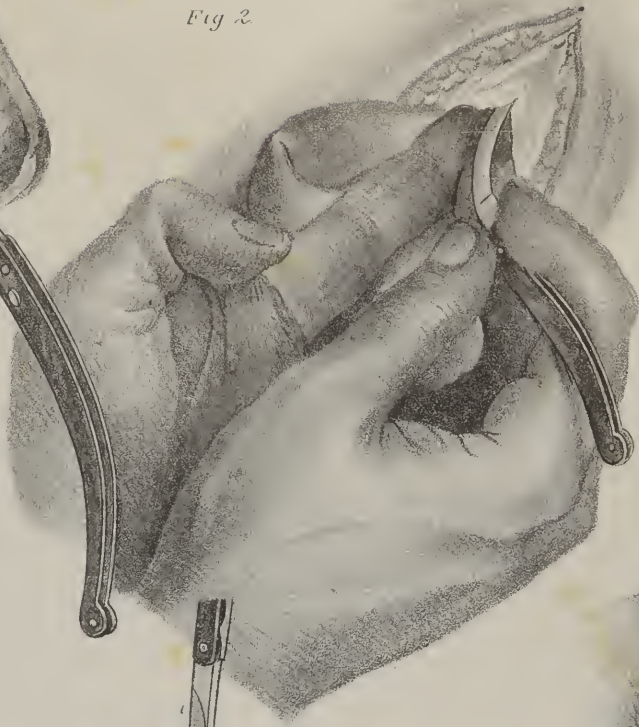


Fig 5

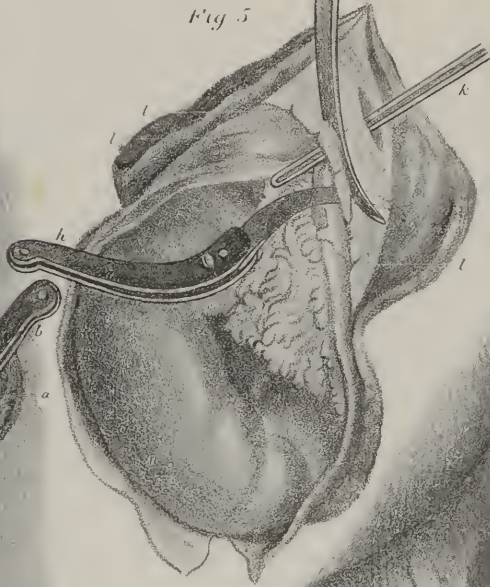


Fig 4



Fig 3



returned before the omentum, nearly as in the ordinary process for the taxis. It is to be gently compressed to cause its gaseous contents to pass into the cavity of the abdomen. The blood from the surface is then to be carefully wiped away. If the loop is small, it may be supported by the first three fingers of the hand, and pressed up through the ring, following it with the fore finger even into the abdominal cavity. If it be large, considerable difficulty will sometimes occur in its reduction. The walls of the abdomen should be relaxed as much as possible, and the surgeon, securing one end of the loop with the first three fingers of the left hand, introduces the other end, portion by portion, completely into the cavity of the abdomen with the index finger. The omentum should next be reduced. No attempt is to be made to return the sac. The wound is to be closed with a few sutures, passed merely through the integument and supported by adhesive straps. Lint spread with cerate, a stout compress, and a spica bandage, complete the dressing. The patient is to be kept carefully in bed during the cure, with the thighs and thorax flexed, and must on no account be allowed to rise for the purpose of defecation, for fear of reproducing the hernia. If the intestine is found gangrenous to a limited extent, the affected portion should be retained at a level with the ring; and the orifice left after the detachment of the slough may in favourable cases close spontaneously in the course of a few weeks. If the gangrene extends to a considerable part of the calibre of the intestine, or involves an entire loop, the bowel must be left unreduced, and a portion of its healthy structure brought to the border of the ring. If the omentum is found gangrenous, it is to be excised—the course to be pursued in regard to it being precisely the same as that already mentioned in reference to wounds of the abdomen, with strangulation of this structure.

If, after the operation for stricture, the hernia is found irreducible in consequence of broad adhesions, which cannot be dissected up without danger of doing injury to the intestine, it is, even if in nowise affected with gangrene, to be left in place, the integuments brought together over it, and the wound merely covered with a pledget spread with cerate. It might under such circumstances be expected that an additional portion of the intestine would be liable to escape, but such has not been found by experience to be the result. For if the function of the bowels be restored after the division of the stricture, and the patient be kept rigidly to the horizontal posture, the amount of the protrusion will gradually diminish, and the parts may even in the end be gradually withdrawn into the cavity of the abdomen. The same practice is also ordinarily to be pursued in case the caput cæcum has been forced down and for some time retained in the tumour, when, so far as the experience of the author goes, it will be found too firmly adherent to allow of its immediate reduction.

When the tumour is very large, and known to be habitually irreducible, the exposure of its contents to the air, by laying open the whole of its coverings, will, as remarked by Sir A. Cooper, be attended with danger. In such cases, the practice recommended by this distinguished surgeon is to make a small incision over the neck of the tumour, and divide the stricture, leaving the viscera in place.

The same practice has been adopted, especially by some Neapolitan surgeons, as a general rule for all hernial tumours without

distinction, with the exception that they immediately return the viscera into the abdomen provided they are found reducible. A most serious objection to the practice is, however, the uncertainty in which the surgeon must remain in regard to the condition of the organs, as the narrow wound could scarcely give sufficient room for their thorough examination.

Another process employed in small recent herniæ, amenable to the same objection, consists in the reduction of the tumour, sac and all, after the division of the stricture on the outer side of the sac, and without the opening of its coverings. This practice was resorted to by Petit and Monro, and has lately been strenuously advocated by Mr. Key and Mr. Luke, of the London Hospital. It has not, however, received the general sanction of the profession, though Mr. Fergusson and M. Velpeau deem it worthy of more consideration than it has yet met with.

It has been proposed to relieve the bowels in certain cases of *inguinal hernia*, by a subcutaneous division of the stricture. The object of this process is to avoid the exposure of the bowel to the air, and enable us to return it into the abdomen by the taxis, without leaving any external wound beyond that of a trifling puncture.—A case most successfully treated in this way, by the author, will be noticed on the last page of this work, under the head of subcutaneous operations.

CRURAL OR FEMORAL HERNIA.

Surgical anatomy.—In this form of hernia the protrusion takes place *below Poupart's ligament*, through an opening called the crural ring. It has been already observed, in the description of the parts concerned in inguinal hernia, that Poupart's ligament is stretched from the anterior superior spine of the ilium to the spine and crest of the pubis, forming an arch over the concave front surface of the os innominatum. In its connection with crural hernia, it is important to have more particularly in view that portion of the ligament which is attached to the spine of the pubis, and for about three-quarters of an inch to the crest of this bone, which forms a part of the linea ilio-pectinea. That dependency or reflection from the lower edge of Poupart's ligament, which arches down along the crest in a direction slightly backwards and inwards, has received the name of Gimbernat, and presents a sharp concave edge which looks outwards towards the iliac vein. This concave edge forms the inner boundary of the *crural ring*. To ascertain what forms the outer edge of the ring, it will be necessary only to examine the parts which fill up the greater portion of the space between the concave face of the os innominatum and Poupart's ligament. Commencing from the spine of the ilium, we find the space included between the outer half of Poupart's ligament and the outer half of the concave face of the bone below it, completely filled up by the psoas magnus and iliacus internus muscles, as they make their way in a common musculo-tendinous mass downwards and inwards to their insertion on the trochanter minor of the thigh bone. The inner edge of this common tendon slopes onwards towards Gimbernat's ligament, so as to cover the pectineal protuberance, on which sloping edge rest the iliac artery and vein as they pass into a long triangular fossa at the top of the thigh, the base of which is formed by the inner half of Poupart's ligament. As the walls of the vein (which is placed immediately

to the inner side of the artery) are but little resistant, and liable to be compressed by the yielding of Poupart's ligament to the traction of the muscles inserted upon it, a space has been left between its inner margin and the edge of Gimbernat's ligament. This space is crossed by some loose cellular tissue, called the crural septum by Cloquet, and fascia propria by Cooper—which is pierced by the ascending absorbent vessels; it lodges one or two small lymphatic glands—and constitutes the proper crural ring. It is on the average about half an inch in diameter, and from the peculiar arrangement of the fascia, constitutes the only point at which the viscera can protrude in crural or femoral hernia. The fascia iliaca, which covers the abdominal face of the iliac muscle, is continuous over the linea ilio-pectinea with the pelvic fascia, and extends downwards towards the top of the thigh to get a firm attachment between the spine of the pubis and the anterior superior spinous process of the ilium. In the outer half of this space it is connected with Poupart's ligament, which it firmly binds down upon the surface of the psoas magnus and iliacus tendon. In the inner half of this space it cannot, in consequence of being placed behind the iliac vessels, reach the ligament; it is accordingly reflected along the sloping inner surface of the muscles and the concave face of the bone up to the edge of Gimbernat's ligament, and is continued down behind the vessels upon the thigh so as to make the posterior half of their sheath. The transversalis fascia, which, as has already been shown in the surgical anatomy of inguinal hernia, is connected to the inner edge of the whole length of Poupart's ligament, is in contact with the iliac fascia both at the outer margin of the artery and at the outer edge of Gimbernat's ligament, and is continued likewise down, but in front of the vessels, so as to form their anterior half of the sheath. Between these two fasciæ a partition passes across between the artery and vein. As the sheath of the vessels formed by these two fasciæ is connected to the edge of Gimbernat's ligament, it must necessarily include the crural ring, and cause the hernia, when it escapes by this opening, to pass down into the sheath of the vessels. The sheath, which is larger on the side of the abdomen than is necessary to embrace the vessels, is gradually narrowed, so that at the distance of an inch and a half below Poupart's ligament—where the internal saphena penetrates its anterior wall to open into the femoral vein—it is found capable merely of embracing the artery and vein, and becoming like the ordinary sheaths which surround the vessels. It must necessarily be funnel-shaped in its form. Over the orifice of this funnel is spread the ordinary peritoneal lining of the abdomen, which, when a hernial protrusion occurs, is necessarily pushed before the viscera as far as they can freely descend—which is to the end of the funnel—the place of entry of the saphena vein. If the viscera are subjected to further protrusion, as they cannot readily dilate the sheath of the vessels below this point, they widen the orifice made for the saphena vein, or one of those for the passage of the large absorbent trunks in the anterior wall of the sheath, so as to escape through its opening. This orifice when dilated is sometimes, though improperly, spoken of as the accidental crural ring. The passage between this opening and the proper crural ring may with propriety be designated the crural canal.

There is one part more that requires notice on the side of the abdomen, and that is the arrangement of the arteries. When

these have their normal origin, none of them are placed in danger from the operation in this form of hernia, unless the incision of the stricture be made of unnecessary length, or in the upward and outward direction towards the trunk of the epigastric. But occasionally—about once in six times according to M. Bourguery—the epigastric artery, instead of arising from the femoral, comes off from the obturator and winds over the passage of the crural ring as it goes to take its position on the abdominal muscles, so as to be placed over the neck of the sac;—or the obturator comes off from the epigastric, and occupies as it runs towards its foramen the same position in relation to the neck of the sac. Under either of these circumstances the vessel, in the division of the stricture at the neck of the sac, would, unless care was exercised, be more or less in danger of injury.

If we examine the parts on the surface of the thigh below Poupart's ligament, we find the crural canal, and the viscera which it lodges, in hernia, deeply placed below several layers in the triangular fossa before spoken of, the walls of which are at this point formed between the pectineus muscle—which runs from the body of the pubic bone outwards and downwards—and the common tendon of the psoas magnus and iliacus muscles, which runs downwards and inwards—these two parts being situated at the corresponding margins of the sheath of the vessels.

If we begin with the deeper seated of these coverings of the thigh, we find, first, the strong membrane called the fascia lata, which serves as an aponeurosis to embrace tightly the muscles, and is connected to all the bony margins of the pelvis and to the inner and lower face of the ligament of Poupart and Gimbernat, so as to keep in check the tendency of the abdominal muscles to draw the crural arch upwards. This fascia is simply spread circularly over the surface of the muscles of the thigh up to the point about an inch and a half below Poupart's ligament, where the great saphena vein, which ascends on the external surface of the fascia, empties into the femoral. The arrangement of the fascia is here more complex for the purpose of giving to the vein a passage sufficiently free to prevent its becoming constricted. Immediately under the place where the saphena vein turns inwards to the femoral, the fascia lata splits into two portions with a semicircular edge, concave upwards, at the place of division. The inner one of these two portions is called the pectineal, as it covers that muscle up to the crest of the pubis, where it is attached at the place of insertion of Gimbernat's ligament. The outer portion, called the sartorial, at its place of separation from the pectineal, continues the sweep of the semicircular curve formed under the saphena vein, so as to cross over the front part of the sheath of the vessels in a falciform or crescentic fold, in order to get its attachment along the inner edge of Poupart's and Gimbernat's ligaments, at the latter of which it again becomes continuous with the pectineal portion. The concavity of this falciform or crescentic process presents downwards and inwards. The inner end of it, which becomes narrow as it follows round the concave or outer edge of Gimbernat's ligament to join the pectineal fascia, crosses necessarily the crural ring, and presents a cutting edge downwards and backwards, which is adherent to the sheath of the vessels. This thin prolongation of the crescentic process is considered one of the seats of stricture, and is known as Hey's ligament.

From this description it will be seen that a sort of oval opening

is formed on the inner and front side of the sheath of the vessels, by the separation of the fascia at the saphena vein, and their subsequent union at the point of insertion on Gimbernat's ligament and the crest of the pubis. Through this opening the hernial protrusion makes its way, and becomes more superficial after it has dilated the saphenous orifice in the sheath of the vessels, pushing before it a thin cellular layer which is found spread between the opposite edges of the two portions of the fascia lata, and is enumerated as one of the coverings of hernia under the name of the cribriform fascia.* Over the fascia lata, and across the oval orifice formed in it, is spread the superficial fascia. This is frequently found loaded with fat, and is formed of two layers, between which are lodged the superficial lymphatic glands of the groin. The outer layer of this fascia is directly continuous with the superficial fascia of the abdomen; the other is attached to the inner edge of Poupart's and Gimbernat's ligaments, and lines the vertical fold which constitutes Hey's ligament, with which it is sometimes thickened in cases of strangulated hernia.

In crural hernia, the viscera as they protrude push the peritoncum and the crural septum before them, first get into the crural ring between the edge of Gimbernat's ligament and the vein, then pass under the edge of the ligament, then under that of Hey's ligament, which is immediately adjoining the former, but still more sharp and prominent; and if stricture does not now take place, pass down the crural canal, and turning at a right angle in its course, dilate the orifice for the saphena vein, and raise up as its coverings the cribriform fascia, the superficial fascia, and the skin. If the protrusion should be extended further, as observed in some old cases of hernia, it separates the superficial fascia from the fascia lata—in the direction in which the connection is most loose—towards the anterior superior spinous process of the ilium, so as to form a tumour overlapping Poupart's ligament. In doing this it may, after pushing outwards the cribriform fascia, dilate one of the openings by which the absorbents traverse this layer, and form a long sac divided into two cavities at the point where it is girdled by the fascia. Two cases of this description have recently occurred to me in operations on the living subject—one of which was performed during the winter of 1843-4 before the class of the Jefferson Medical College at the Philadelphia Hospital, and the other on a patient of Dr. Franklin, of this city. In both these instances the cysts or cavities of the sac—the effect of previous protrusions—were filled with fluid, a small knuckle or loop of intestine being found strangulated by a thickened mass of omentum which had partly blocked up the ring. But the cutting edge formed by the septum between the cysts—a point of pathology that has not escaped the observation of Sir A. Cooper—was such as to show that it might readily, had the intestine passed through it, have been made the seat of stricture.

Treatment of Crural Hernia.

The reduction of the tumour in this form of hernia is to be attempted by the application of the taxis, very much as has already

* The sartorial and pectineal portion of the fascia lata will also be found to be continuous with each other, behind the sheath of the vessels, by a thin layer which covers the tendon of the iliacus and psoas muscles, and is closely adherent to the posterior part of the sheath. This part, however, is not concerned in the operation.

been described for inguinal hernia. It will, however, be necessary to recollect the circuitous route by which the viscera escape, and make the pressure first downwards, to pass them through the opening in the sheath of the vessels, and then upwards in the direction of the crural canal. A small knuckle of intestine, not larger than a hickory nut, is sometimes strangulated at the seat of the crural ring; this, when the patient is obese, it may be very difficult to detect. If, with the rational signs of strangulation not relieved by the ordinary internal treatment, there is pain and soreness on pressure over the crural ring, though no distinct tumour is apparent, there is probably a hernia, and it will be the duty of the surgeon to cut down to determine the question. Even if, with the prevalence of these symptoms, there should be merely a greater fullness of the region of one groin than the other, though no soreness or pain be developed on pressure, he will still be justified in making an examination with the knife—and operation of itself unattended with danger when properly performed—as cases of fatal strangulation have, under such circumstances, been known to occur, three of which have come within the knowledge of the author. The general rule applied in strangulated hernia, that the smaller the parts protruded the greater is the danger of the early development of gangrene, is especially applicable to the crural form of the affection.

Operation for Strangulated Crural Hernia.

In many of its details, the operation for this form of hernia will correspond with that just described. It will, therefore, only be necessary to point out its peculiarities. A simple incision of the skin, made obliquely downwards in the axis of the tumour, will usually suffice. If the hernia is of large size, this incision may, though I have rarely found it requisite, be crossed at its lower end by another, so as to convert it into a \perp reversed. In some instances a crucial incision has been employed, for the purpose of more readily uncovering the viscera, and facilitating the access to the stricture. The fascia superficialis, which will often be found thick and loaded with fat and enlarged glands, is to be opened on the director to the same extent and in the same directions as the skin. The fascia propria* is usually the layer which next comes into view; it is formed by the crural septum, which has been forced down before the sac, is moulded exactly upon the form of the latter, and is so thin and transparent that it might be mistaken for the sac itself, especially as the latter in this form of hernia is rarely distended with much serum, and is often coated on its outer surface with a layer of fatty matter, that has some resemblance to the omentum. The operator will, therefore, be required to examine closely in reference to cases of this description, for if an attempt be made to divide the stricture on the outer side of this membrane, and thus reduce the sac without opening it—a process even more objectionable in crural than inguinal hernia—the stricture, if it had been formed, as is sometimes the case, in the neck of the sac itself, or in the crural septum, would be left undivided after the return of the viscera.

In case the strangulation of a small hernial tumour of recent formation had taken place before it had dilated the opening in the

* The cribriform fascia will in most instances be found so blended with the superficial, that it cannot be recognized in the operation as a distinct layer.

sheath of the vessels, we would have the sheath as a third covering to divide before reaching the sac.*

After the division of the fascia propria, we fall usually upon the sac; this is to be opened with great precaution on the director, by a simple longitudinal slit. The fore finger is now to be carried up towards the abdomen, to ascertain the seat of strangulation. If it is found in the dilated orifice of the sheath of the vessels, (the accidental crural ring, as it has been called,) its comparative superficial position enables the operator readily to recognize it. If it is at the neck of the sac, at Gimbernat's ligament, or at Hey's ligament, or at that part of the sheath of the vessels immediately below Hey's ligament, where the sheath is thickened by a vertical fold of the superficial fascia, its precise seat is more difficult of detection, and is by no means important, as the same process for division is required in all, *provided the cut be made from the interior of the sac.*

The mode of division at the orifice in the sheath of the vessels (accidental crural ring) is very simple, and is shown completed at Plate LX. fig. 3. Even when a stricture has been found and divided at this place, it is necessary to carry up the finger beyond it to ascertain whether or not there is a second narrowing at the crural ring. In doing this, I have found on three occasions the bowel to slip at once into the cavity of the abdomen, showing conclusively that no stricture had existed at that point. In a great majority of cases it is, however, at this place that the stricture will be found.

A variety of processes have been devised for the relief of the strangulation at this point. That which is most generally approved of is shown at Plate LX. fig. 4, *e.* The left fore finger is to be carried up in front of the viscera, and the end, or at least the nail, inserted under the stricture. An assistant now holds the bowel down, and the surgeon carries up a probe-pointed bistoury (that of Cooper being preferred) flatwise over the finger, engages the probe point under the stricture, then turns the cutting edge upwards and inwards in the direction of the umbilicus, and presses the knife with the finger till the resisting part yields, which usually gives way with a creaking sound, as in the division of a piece of parchment. A slight cut will usually suffice for the introduction of the finger in the ring; the bistoury should then be withdrawn. The surgeon now ascertains if the passage is sufficiently free to admit the finger to move freely, and allow of the return of the bowel without the employment of such pressure as would subject it to contusion. If not, his next object of investigation is to determine whether there is the anomalous distribution of the arteries round the neck of the sac, which has been described at page 294. If none is met with, the bistoury is to be introduced as before, and a further division of the stricture made. An incision to the extent of a quarter of an inch is much greater than is usually required,

* In an operation which I performed, about a year since, on a patient of Dr. Wills, at Downington, in this state, the strangulation of a small knuckle of intestine had taken place without any dilatation of the orifice in the sheath of the vessels, and the fascia propria was recognizable as a distinct layer over the sheath. The seat of the stricture was found just below Gimbernat's ligament, and was rendered very accessible to the knife by drawing the sac downwards with a couple of pairs of forceps—a measure which will, in many of the cases where the patient is obese, be found highly advantageous. The ligament of Gimbernat was found less developed than usual, and of course without its usual reflection backwards, which is intended as the natural barrier against hernial protrusions at this place.

and is the most that under almost any circumstances can be needed. If, on the introduction of the finger, the artery should be found throbbing round the margin of the ring, that point should be selected for the division of the stricture at which the artery is most distant, and it will be well, instead of a single incision, to gain the requisite space by nicking the border of the ring at several points, as shown at Plate LX. fig. 5, *l*, according to the plan of Richter and Scarpa.

The author operated about eighteen months since in a case of old crural hernia, in which, after the division of a first stricture near the ring, another was detected apparently at the neck of the sac, in front of which a large artery could be felt pulsating round the anterior two-thirds of the ring, and equally near it at all points. The plan pursued was to blunt the edge of the bistoury by rubbing it with the roughened side of the dissecting forceps, wrapping it with a waxed thread, so as to leave a cutting surface of not more than a fourth of an inch in length, and proceeding with great caution, and without any sawing motion, in the division of the stricture upwards and inwards, pushing in the finger at the same time so as to keep the vessel elevated above the edge of the knife. In this way the division was safely effected without injury of the artery, and the patient made a rapid recovery. It appears to the author that this course would in most instances be found to answer where the vessel surrounds the ring, for the artery, which lies somewhat loose in the sub-peritoneal cellular tissue, is disposed to give way before the dulled edge of the knife, whilst the stricture band is so firm as to receive the whole action of the instrument; and it is perhaps from this tendency to slip before the knife, that, notwithstanding the frequency of the anomaly, the artery in this operation has been so seldom cut. In such cases it might possibly, though there would be risk of contusing the bowel, answer to resort to the practice of Leblanc, which has been advocated by Malgaigne in all instances of stricture at the neck of the sac in crural hernia—that of dilating the orifice by pushing in, in front of the intestine, the small end of the ordinary spatula blunted on the edge, and rupturing the resisting band by pressing strongly on the circumference of the orifice.

Various other plans have been devised for the division of the stricture in crural hernia. Pott practised the division of the crural arch directly upwards, as shown at Plate LX. fig. 4, *f.* Sharp, its division obliquely upwards and outwards, (fig. 4, *g.*) Sabatier, upwards and inwards, (fig. 5, *h.*) Dupuytren, upwards and outwards, (fig. 5, *i.*) with a curved probe-pointed bistoury cutting on its convex edge, the incision being made from above downwards; and Scarpa, Boyer, and Lawrence, following very nearly the method of Gimbernat, direct the incision to be made inwards upon the edge of Gimbernat's ligament, in a direction nearly parallel with the horizontal branch of the pubis.

Sir A. Cooper rejected the process of Gimbernat, which, according to him, is not only difficult of execution from the depth at which it is performed, but exposes the intestine to a risk of laceration in the traction outwards, that, on account of the narrowness of the passage, must necessarily be made to get room for the bistoury, and especially when a conductor, which is always deemed requisite, is employed, whether that be a finger, a grooved director or a spatula. The space gained by it he also deemed insufficient in cases of large hernial protrusions. After having laid

the sac open up to the sheath of the vessels, this surgeon introduced his finger in front of the viscera, and divided the sheath on its inner side up to the crural arch. If this was not found sufficient to permit the return of the viscera, he either divided simply the posterior edge of the ligament, or made a puncture through the upper part of Gimbernat's ligament, and introduced a grooved director from the opening through the crural ring, upon which the ligament was divided with the knife. This latter process, however, is complicated, and weakens the aponeurosis of the great oblique. Cases may however occur, in which this process, or some one analogous to it, will be found the most appropriate. One of this kind occurred in the wards of Professor Dunglison, and was operated on by the author in the winter of 1832-3. The hernia was of long standing, and had been ill-supported by a truss. A thick mass of omentum was found firmly adherent round the inner margin of a large crural ring, and to the front portion of the sheath in its vicinity, so as to leave within its girth a narrow orifice, in which a small loop of intestine had become strangulated. On laying open the sac, it was found impossible to divide the stricture without cutting through a thick mass of omentum, or dissecting it off from its firm attachment to the neck of the sac. It was deemed better to divide the stricture on the outer side of the sac, puncturing it at its edge of reflection from Poupart's ligament, so as to introduce the end of a probe-pointed bistoury. The nail of the left fore finger was then engaged between the sac and the resisting bands above it, and the edge of Gimbernat's ligament and Hey's ligament cautiously divided close upon the finger nail. The intestine was then returned—but the omentum, in consequence of its firm adhesion, was left in place. As a general rule of practice, however, it will be found better to excise the omentum, especially if it be thickened and hardened, tying such vessels as bleed, than to leave it in place.

The management of the viscera after relief from strangulation in crural hernia, and the subsequent dressing and treatment, are to be conducted on the same principles as after the operation for inguinal hernia, and will require no particular description here.

UMBILICAL HERNIA.

Surgical anatomy.—Umbilical hernia (*omphalocele*, *exomphalos*) escapes sometimes by the umbilical ring, but more frequently at a weakened point in the linea alba, at a little distance below or above it. The *hernia of the linea alba* is the name which has been sometimes applied to this latter variety.

In the fœtus the umbilical ring is a nearly circular orifice, through which run the vein and arteries of the umbilical cord, and the urachus, a fibrous band which extends from the ring to the top of the bladder. When this opening is examined from the side of the abdomen, the peritoneum is seen to dip into it so as to form a sort of pouch. If at the same time some traction outwards is made on the cord, the pouch will be deepened so as to take the form of a funnel, the base of which opens into the abdominal cavity. After the separation of the cord, a solid cicatrix is usually found at the extremity of the obliterated umbilical vessels, at the point at which they had passed through the umbilical opening or ring. If this solid obliteration of the passage is tardily

effected, and the child is fretful, one of the bowels is liable to protrude at the opening, constituting that form of umbilical hernia which is distinguished as the congenital. But when the tumour in umbilical hernia is developed subsequently to the solid closure of the passage, it is found to escape more frequently by a rupture through a weakened point of the linea alba just above or below the ring, than at the ring itself. When it takes place at the ring in an adult, or at any time subsequent to the closure of this opening, it dilates the centre or the side of the cicatrix, and may separate the cord formed by the obliterated vessels and the urachus, and carry them out with it—the tumour expanding in the intervals between them so as to have a lobulated appearance, and be covered merely by a thin peritoneal layer and by the cuticular investment of the cicatrix. More commonly the cords will be found adherent together forming a single rope, the viscera then protruding between it and one of the margins of the ring. The author has met with a case in which an opening had been dilated on either side of the cord formed by the union of the umbilical arteries and the urachus, so that a loop of intestine which had escaped through one orifice and passed back into the cavity through the other, became fatally strangulated over the intermediate vertical band.

The causes which give rise to umbilical hernia, and the mode in which the protrusion takes place, correspond in general so much with those already described in reference to other forms of hernia, that it is not necessary to describe them here with particular minuteness.

Covering of umbilical hernia.—It was formerly believed that there was in umbilical hernia no proper peritoneal sac. But the existence of the sac may always be discovered by careful examination. The author has often noticed it distinct and well formed in small hernial protrusions round the umbilicus, and has been enabled to detect it in large protrusions, though it is there found merely as a thin serous facing to the fibrous tissues on its outer aspect. The peritoneum in the neighbourhood of the umbilicus is far more closely connected to the parts which it lines than at the inguinal or crural regions, and in consequence of this the sac can only be formed in large hernia by the excessive expansion of a small peritoneal pouch. The fascia superficialis and the skin form the two principal tunics in this form of hernia. In obese subjects—especially in women, who are more prone to this affection than men—a thick layer of fat will be found below the skin, masking the tumour, preventing its development forwards, and causing it to spread out as a rounded and somewhat flattened mass, which renders the detection of the hernia somewhat difficult. Fatal strangulation now and then occurs under such circumstances, undetected save by a post-mortem examination, and it will be well for the practitioner to examine closely into the condition of the parts at the umbilicus, in females labouring under hernial symptoms without any apparent cause observable in the crural or inguinal regions. The reduction of this form of hernia in its early stages of development, is readily effected by the ordinary process of the taxis, and the ring after the return of the bowel should be kept steadily closed by a proper umbilical truss. In the congenital form of the affection, the application of the truss, or even that of a section of a small ivory or gum elastic ball, or half a nutmeg so commonly employed by nurses, fastened upon the part with adhesive plaster and sustained with a body bandage,

may be relied upon to effect a permanent cure—the parts at the ring having, as in congenital inguinal hernia, a natural tendency to cicatrization. The facility with which a radical cure can be accomplished in this way, renders unnecessary, at least in most instances, the ligature of the sac by crossing its root with a pin and surrounding it with a thread, a process which is sometimes, especially when the sac is long and tubular, successfully employed for this purpose. In all herniæ of large size the viscera are mostly, so far as the observation of the author extends, more or less adherent, so as to be rendered irreducible, and will require to be supported by a truss with a hollow pad or a properly constructed girdle.

Character of the viscera protruded.—In the congenital form of hernia, a knuckle of the small intestine is ordinarily alone found bulging through the ring. In the umbilical hernia of the adult, there is in almost every case a protrusion of the omentum, with or without a portion of the small intestine, the omentum lying in front of the bowel.

Operation for Strangulated Umbilical Hernia.

This, which is sometimes demanded, though less frequently than in the other forms of hernia, is practised in the following manner. A simple longitudinal incision, when the tumour is small, is to be made over its top; or a crucial or T incision, if large, over its neck. The skin is usually so tensely stretched, that it cannot be raised up in a fold and divided from the base. The incision is to be made from above downwards, and with extreme caution, in consequence of the usual thinness of the envelopes, the absence of any fluid in the sac, and the impossibility of separating the sac as a distinct layer. The first object encountered after the division of the tunics is the omentum. This is to be unfolded and the condition of the parts at the ring carefully examined, for even though no intestine be apparent in the body of the sac, a loop may be compressed at the margin of the ring, or even through an orifice in the omentum, or by the ligamentous cord formed by the obliterated vessels, as in the case above noticed. It sometimes happens that the mere unfolding of the omentum for this purpose relieves the intestine by effecting a change in its position, so that it may be reduced without the necessity of dividing the stricture.

When it is necessary to use the knife, the division of the stricture should be made upwards and to the left, for the purpose of avoiding the umbilical vein in infants, and the great lobe of the liver in the adult. A small incision will usually suffice. The intestine is to be reduced first, as it has been the last part to escape. The after treatment of the case will be precisely the same as that already given for “wounds of the abdomen with protrusion of the viscera.” If the hernial tumour is large, and known to be irreducible, an incision should be made at its neck, of sufficient size only to allow of a safe division of the stricturing parts, in order to avoid the irritation which might arise from the exposure of a large mass of viscera to the action of the air.

VIII. OPERATIONS UPON THE ANUS AND RECTUM.

The diseases of this region, which require operations for their relief, are very numerous; those described here consist of Imperforation of the Anus and Obstruction in the Lower Bowel; Polypous Tumours of the Rectum; Prolapsus of the Mucous Membrane of the Rectum; Invagination of the Rectum; Cancer of the Rectum; Hæmorrhoids; Abscess by the side of the Rectum; Fistula in Ano; Fissure; and Stricture of the Anus.

OF IMPERFORATE ANUS. (PL. LXI. FIG. 2.)

The imperforation of the anus arises from a defective development of the lower part of the rectum. This may consist, 1st, merely in the closure of the external orifice by a thin livid-coloured membrane, through which the dark hue of the meconium can be observed; 2d, of the complete fleshy closure of the anus, the natural hollow at this part of the peritoneum being filled out evenly with the surrounding skin, the rectum terminating in a blind pouch half an inch to an inch above the surface; 3d, the rectum may be developed only at its upper end, or altogether deficient, the colon terminating in a *cul-de-sac* attached to the promontory of the sacrum; 4th, the rectum may have an unnatural outlet, opening into the bladder, urethra, or vagina; and 5th, the rectum, though the proper external orifice exist, may be found closed some little distance above by a transverse membranous septum.

1. *Of the membranous closure of the anus.*—Happily this first variety is the one which is most frequently met with. It requires but simple treatment. A crucial incision is to be made through the membrane so as to discharge the meconium. The angular flaps thus formed are to be excised, and the new passage preserved patulous by the daily introduction of the finger previously oiled. The employment of bougies and catheters for this purpose, as is commonly practised, is not unattended with danger, in consequence of the soft and delicate organization of the mucous membrane of the bowel at this early age.

If the transverse septum forming the fifth variety is found obstructing the passage at some distance from the orifice, it is to be divided in a similar manner by a crucial cut, but the bistoury should be wrapped with a thread to near the end, and cautiously carried into the passage on a grooved director. I have succeeded in one instance, after puncturing the septum, in dividing it readily and safely with Cooper's hernia bistoury. Either of these instruments is safer and more efficient than the trocar or pharyngotome, which have been recommended for this object. It will be found useful, after the division of the membrane in this form of the affection, to introduce a mesh well oiled into the passage, which should be secured by a thread attached to one end, and fastened to the skin of the buttocks by adhesive plaster.

2. *Of the complete fleshy closure or congenital deficiency of the anus.*—If no trace of an outer orifice is found, the operation becomes more difficult and uncertain. If any, even an indistinct fluctuation of the meconium can be felt, it may, however, be undertaken with considerable prospect of success, and the surgeon, even when this is not the case, will, under most circumstances, be justified in cutting in the direction of the canal. A sound may

be introduced into the urethra to determine the direction of the passage; this is a measure, however, especially in male children, sometimes difficult to accomplish, and is not absolutely necessary. The following process has been successfully employed by the author upon a female infant.

Ordinary process.—The child is to be placed as in the lateral operation for stone. A longitudinal incision of an inch and a quarter in length is to be made just in front of the os coccygis, traversing the point for the natural outlet of the anus. This is to be crossed at its anterior end by a horizontal incision, so as to allow the formation of two flaps, which are to be reverted outwards by the fingers of an assistant. The longitudinal incision is then deepened little by little, introducing from time to time the fore finger of the left hand, to ascertain the position of the vagina or bladder, to feel for the fluctuation in the pouch of the rectum, and to serve as a guide to the knife. When the point of the rectum is exposed, it is to be opened by a crucial incision, and the meconium discharged. The freedom of the new passage is to be maintained by dilatation with a mesh of lint.

Process of Amussat.—This surgeon has been successful in reaching the rectum when it had terminated in a female child two inches from the surface. After making the incision of the integuments as above directed, he ruptured with his finger the cellular tissue between the vagina, the coccyx, and the sacrum, using the knife only to divide the stronger bands. A sound placed in the vagina served to show the direction of that passage, and prevent its being injured. The end of the rectum, when found, was seized with a double hook and drawn downwards, the surgeon loosening its attachment with his finger, applying the knife but upon one side—that next the vagina, where the adhesions were more firm and required great care in their division. A double ligature was passed with a needle through the pouch as soon as it was brought sufficiently low, by means of which and the hook, the intestine was brought down through the new opening to the level of the skin. The pouch was then opened by a longitudinal incision, and the two edges fastened to the corresponding lips of the skin by five or six points of suture, to prevent the faecal matters escaping into the cellular tissue between the mucous membrane and the skin.

If the operator should altogether fail to detect the end of the rectum, he will be justified—as death must inevitably follow unless the obstruction of the bowel be removed—as a last resort, to pass up a trocar a little space further in the presumed direction of the bowel, and if he does not succeed in finding the bowel, recur, as has been several times practised latterly, to the establishment of an artificial anus in the left iliac or lumbar region. In cases where the blind end of the rectum could not be detected in the wound of the perineum, it has been recommended by Mr. Martin, but not to the knowledge of the author carried into practice, to open the sigmoid flexure of the colon by the process of Little, and carry from the cavity of the bowel a probe or a sharp-pointed stilet down towards the anus.

Process of the author.—The author has twice successfully practised the process described below, on patients of Dr. Fricke, and Mæhring, of this city, and would, both as regards the safety and celerity with which it may be performed, strongly recommend it to the notice of the profession.—In both cases the bowel had terminated in a cul-de-sac, an inch short of the surface, and in one

of them the operation by the ordinary process had been attempted without success, by a respectable practitioner of this city.

The child is to be held as directed in the process above given.—The surgeon is to press with the fore finger over the proper site for the anus in order to determine whether any fullness or fluctuation can be felt, from the meconium accumulated in the cul-de-sac of the bowel. If it can be felt, the operation becomes at once simple and plain. If it cannot be felt, the operation must be proceeded with the same, though success is then uncertain, inasmuch as we cannot tell till after the puncture is made, whether or not the bowel has terminated at a point accessible from the perineum.

Having carefully examined the parts, so as to determine the direction in which the rectum ought to be lodged, I introduce by puncture the sharp-pointed grooved director of M. Guerin. This instrument, which is but a common grooved director, terminating in a knife point, enters readily, and would leave a wound of but little moment, in case we should encounter one of the rare instances in which the bowel had terminated short of the pelvis. If the cul-de-sac is within one or even two inches of the surface, we will be apprised of the moment at which it is pierced, both by the freedom with which we can move the point, and the trickling of the meconium down the groove of the instrument. I now pass a narrow blunt-pointed tenotomy knife, along the groove of the instrument, and make an incision forwards and backwards, but in the median line, so as to make an opening nearly equal to the natural channel of the gut. The meconium is then freely discharged. I next make a cross cut through the integuments at the external surface of the wound, so as to enlarge the opening and give more space to hunt for the end of the bowel, which I draw down with a pair of forceps or a bent probe, and attach the cut edge of the mucous membrane to the surface of the skin, with five or six points of suture after the manner of Amussat. This operation is readily done, and in each case in which the author has tried it, has been permanently successful. The new anus should to appearance be made unnecessarily large, otherwise, after the raw surfaces cicatrize, the orifice will be so small as to require dilatation with bougies. The passage of the faecal matters will prevent union by first intention between the edges of the skin and mucous membrane; but the sutures will hold them so closely applied, that but a narrow band of cicatrix will be formed between them. In a case in which the author has but recently operated, there was a fistulous communication about an inch in length, between the cul-de-sac of the bowel and the lower end of the vagina. This passage was permanently blocked up by the displacement of the bowel, in bringing it down to attach the mucous membrane to the skin. In the drawing down of the bowel, in these cases, there is neither so much difficulty nor danger as has been apprehended by some surgeons.

3. *The rectum opening by an abnormal orifice in the urinary passages or vagina.*—If the rectum opens into the bladder or urethra, it will form a kind of cloaca, as in birds, a malformation readily detected in consequence of the urine being tinged with the greenish meconium. This kind of malformation is most frequently observed in male children, and the operation for its relief is attended with some difficulty and danger. In females the abnormal passage generally opens into the vagina, and an operation for the establishment of the natural rout may be attempted with better prospect of success. It is not, however, in this sex unattended with danger,

and it would in many cases be more prudent to desist from all active proceeding, inasmuch as in many instances, some of which have come under the observation of the author, individuals have grown up to womanhood without any great apparent inconvenience, and been capable of bearing children—the circular fibres around the vaginal orifice of the intestine exercising perfectly the office of a sphincter muscle. But in case the infant should suffer from the insufficient size of the passage, or from other causes it be deemed prudent to remedy the deformity, the attempt may be made in the following manner. A bent grooved director is to be passed from the vaginal aperture into the rectum, and from the natural site of the anus a trocar or sharp-pointed bistoury thrust through the soft parts so as to strike the groove. The opening thus gained should be kept pervious and enlarged by dilatation. If it be found difficult to accomplish the latter object, it has been recommended to slit open upon the director the whole wall intervening between the abnormal and regular anal orifice. After this division of the parts, no further dressing will be required save the daily introduction of an oiled finger to keep the aperture open, and there is a prospect that the edges of the anterior margin of the wound may unite, so as ultimately to render the vagina perfect. Dieffenbach, in a case where the rectum terminated in the vagina, entered the knife immediately below the fossa navicularis, but outside of the vagina, into the groove of a director introduced from above, and

without opening the rectum any farther, divided all the cellular and muscular tissue between the point of the first puncture and the os coccygis. He then dissected off the rectum from the preternatural aperture, and detached it for some distance from the surrounding parts, so as to be able to draw downwards the end of the bowel, and attach it by a few sutures to the margins of the outer incision. The cut edge of the rectum united to the skin, and the fistulous opening in the vagina closed after being touched once with lunar caustic. He afterwards formed in the same case an artificial perineum, by detaching the rectum still farther from the vagina, and fastening the soft parts between by two short hare-lip pins.

If the rectum opens into the urethra, either in male or female children, a similar plan is to be followed. A sound is first introduced into the bladder, or if possible through the abnormal orifice into the rectum, and so directed that it may be felt from the perineum. An incision is then made upon it from near the os coccygis, and the rectum dissected off from the fistulous aperture, in order that it may be pulled out and fastened to the outer wound. The same method of operation has been practised by Mr. Fergusson when the rectum opens into the bladder, but the formation of an artificial anus by one of the following methods of operation will afford a better prospect of saving the life of the child.

4. *Formation of an artificial anus.*—This is rendered necessary

PLATE LXI.—OPERATIONS UPON THE RECTUM.

Fig. 1.—*Ligature of a polypous tumour of the rectum.*—The dilatation of the rectum is made with the two-branched fenestrated speculum of Charrière. The polypus is drawn down with a blunt hook, so as to allow the ligature to be thrown around its neck. The ligature is to be tightened either with an ordinary double canula, or with a *serre-nœud*, as shown in the drawing.

Fig. 2.—*Excision of several folds of the integument at the circumference of the anus, for prolapsus of the bowel. (Process of Dupuytren.)*—A fold of the skin is shown raised with a pair of forceps, so as to be readily snipped away with a pair of scissors curved on the flat. Three of the folds have been previously excised. The cicatrization of the raw surfaces narrows the orifice of the anus, so as to render it capable of restraining the prolapsus.

Fig. 3.—*Excision of a circular protuberance of the mucous membrane of the rectum. (Process of Ricord.)*—The projecting ring of the membrane is sustained by two threads, held by an assistant. The excision is made by grasping the prominent part with the forceps, and shaving it off with the bistoury.

Fig. 4.—*Excision of the inferior part of the rectum, in cases of cancerous degeneration. (Process of Lisfranc.)*—The anal end of the rectum has been detached from the parts on its outer surface, by two semi-elliptical incisions upon its sides. The left fore finger of the surgeon is then introduced so as to draw the rectum down, in which position a couple of assistants secure it with hooks. The surgeon then, with a pair of scissors curved on the flat, incises circularly the intestine above the seat of the cancerous degeneration.

(*Figs. 5, 6.*) OPERATIONS FOR IMPERFORATE ANUS, AS PRACTISED ON A FEMALE INFANT.

Fig. 5.—(*Process of Amussat.*)—A longitudinal incision has been made across the usual place for the orifice of the anus, and this crossed at its anterior end by a horizontal cut, so as to allow of the formation of two flaps, which are to be reverted outwards by the fingers (*a, b*) of an assistant. A sound (*e*) is then introduced into the vagina to serve as a guide in the extension of the incision towards the cul-de-sac, by which the rectum has terminated at some distance above the skin of the perineum. The loop of a ligature (*c*), passed with a needle, serves to draw downwards the pouch of the rectum, while the surgeon opens it by a crucial incision with the bistoury.

Fig. 6 shows the conclusion of this operation. The horizontal wound is closed by sutures. The margins of the longitudinal wound are united to the divided portions of mucous membrane, and converted into an anal orifice.

Fig 2

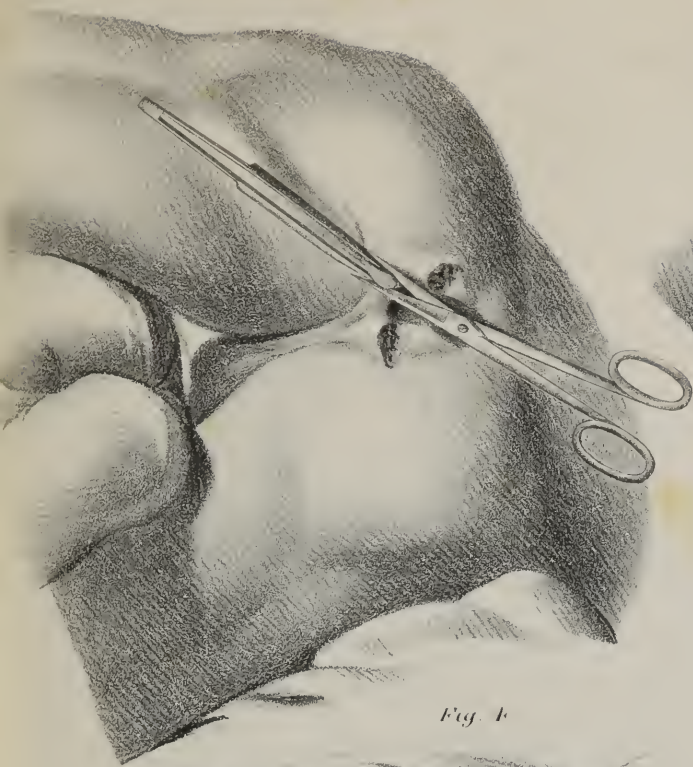


Fig 3

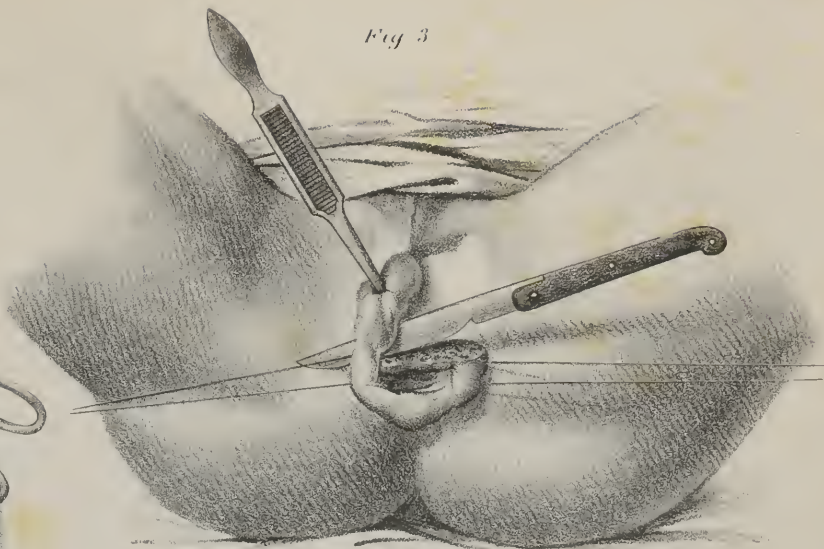


Fig 1

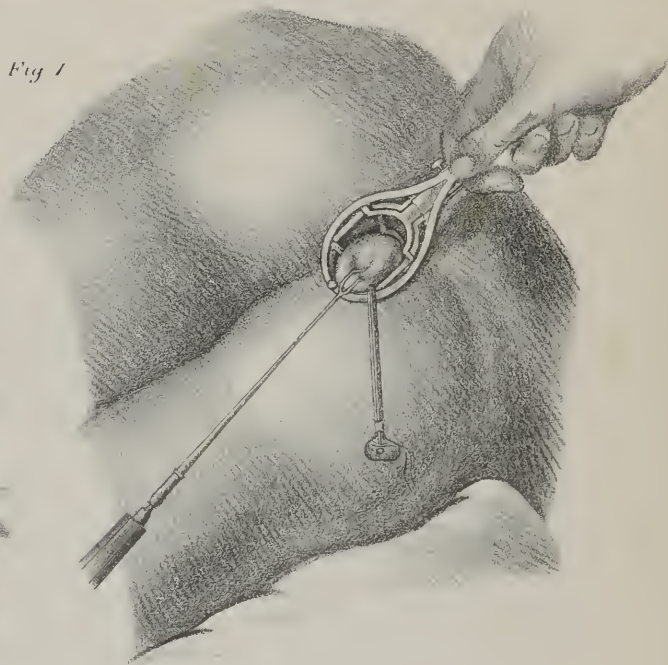


Fig 4

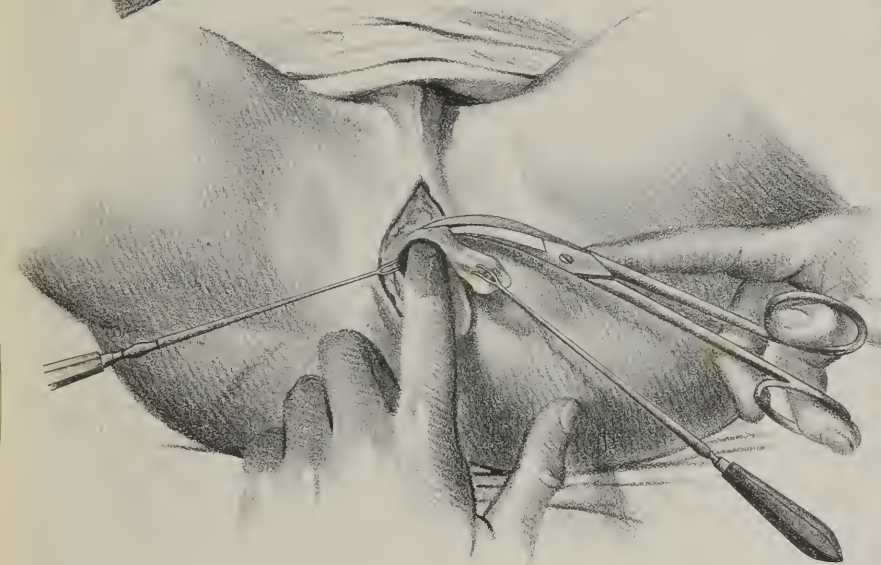


Fig 6

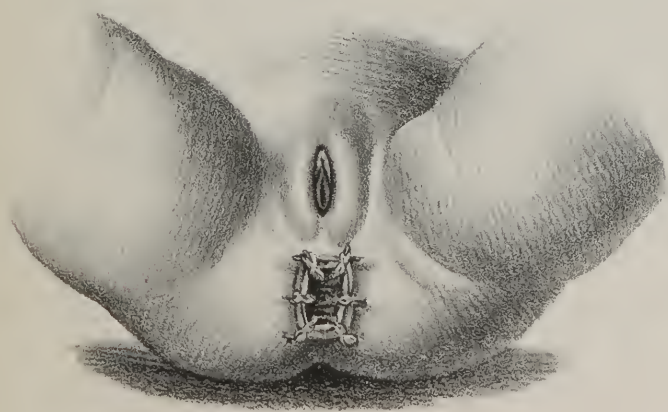
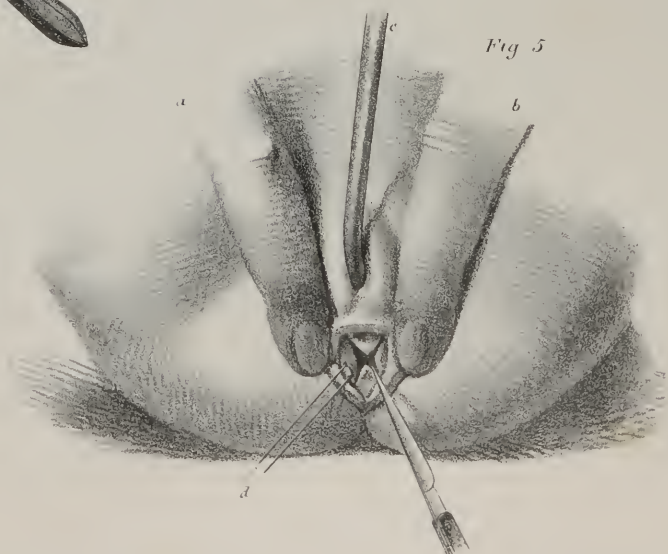


Fig 5



when the rectum terminates in the lumbar region, and may be resorted to under the circumstances just noted. The method has also been employed by Dr. Wm. Ashmead, of this city, and M. Amussat, of Paris,* in cases of adults, where the rectum or sigmoid flexure of the colon had been rendered impervious by stricture, or by a degeneration of structure not susceptible of relief by other measures of treatment.

By the process of Little. Opening of the front part of the sigmoid flexure of the colon.—The infant is to be placed on the back, with its thighs held in the extended position. An oblique incision an inch and a half to two inches long is to be made on the left side, parallel with and a little above Poupart's ligament; the different layers of the abdominal walls, as well as the peritoneum, are to be divided in succession. The sigmoid flexure of the colon presents itself in the gap, of a livid hue from the meconium with which it will be found distended. The intestine is to be opened in the direction of the wound, and maintained attached to the skin by a ligature passed through its mesenteric folds. At the end of three or four days the intestine becomes adherent to the margin of the wound, when the thread may be removed.

Process of Pillore. Opening of the front part of the cæcum.—This is, in fact—except as regards the intestine opened, and the operation being on the right side—the same as the process just described. The lips of the incision in the cæcum are to be fastened by several points of suture to the margins of the divided skin.

Process of Callisen. Opening of the descending colon from the lumbar region, and without division of the peritoneum.—This surgeon directed the incision to be made between the last rib and the crest of the ilium, immediately over the external or anterior edge of the quadratus lumborum muscle. In this direction there are no vessels to be opened that will require ligature, as the tendons merely of the broad muscles of the abdomen are cut, and the surgeon falls upon the cellular space behind the colon, where this bowel is, especially in the adult, left to a certain extent uncovered by the peritoneum. The bowel is to be opened, and the edges fastened to the cutaneous incision, as in the process of Pillore. In infants, however, it is not unusual to find the colon floating, and surrounded by peritoneum like one of the small intestines. Under such circumstances the peritoneum would necessarily have to be opened, and the operation would present but little advantage over that of Little.

The process of Dr. Ashmead, applied to the adult, is nearly the same as that of Callisen.

The process of Amussat† is the same as that of Callisen, with the exception that the external wound is directed more transversely, so as to divide the fleshy bellies of the abdominal muscles. In the exhibition to my class of the various modes of forming an artificial anus on the dead body, the process of this surgeon has appeared to me entitled to a preference over the rest. It may be practised upon the left or right side, according to the site of the obstruction. The patient is to be placed so as to rest upon his knees and elbows, and a little inclined upon one side, in order to

present uppermost the region of the loins, upon which the operation is to be performed. An incision is to be made midway between the last rib and the crest of the ilium, parallel with the crest, commencing opposite the outer edge of the sacro-lumbalis muscle. The incision is to be extended down so as to divide the posterior margin of the three broad muscles of the abdomen, and the anterior portion of the latissimus dorsi and quadratus lumborum. At the back part of the wound will be found the layer of fat which is extended downwards from the kidney, and at the front part the parietal peritoneum, through which may be discovered the small intestines. By tearing the fatty matter at the posterior third of the wound with the point of the director, the cellular extra-peritoneal surface of the colon is exposed, through which a couple of threads are to be passed with a needle in order to draw it to the middle of the external wound. The intestine is then to be seized with the forceps, and opened by a crucial incision with the bistoury, while an assistant separates with his fingers the lips of the external wound. The margin of the intestine is next to be fastened by four hare-lip sutures to the surface of the skin in the middle tract of the wound, for the purpose of preventing the escape of fecal matters into the loose cellular tissue of the region of the colon. The other portions of the external incision are to be closed with hare-lip sutures, in order to effect union by first intention.

If, in forming an artificial anus in the lumbar region, there be difficulty in distinguishing the colon from the small intestine, the following sign, according to M. Amussat, may be relied on for its solution: The small intestines undergo a motion of alternate ascent and descent, in expiration and inspiration, in which the colon does not participate. If, therefore, he says, the exposed intestine present this oscillation, it is small intestine, if not, it may be presumed to be the colon.

POLYPOUS TUMOURS OF THE RECTUM. (PL. LXI. FIG. 1.)

Tumours of this description are but rarely observed. When met with, they present the regular pyriform shape of tumours of this class, and are soft, smooth, and spongy. They may be simple or lobulated, and spring from the lining membrane of the bowel by a narrow pedicle or a broad root. They vary in size from a pea to a pullet's egg, and may, in consequence of their shape and vascular character, be readily mistaken for hemorrhoidal tumours. They usually arise near the margin of the anus, though in some instances their place of origin has been found so high as to be beyond the reach of the finger. The method for their removal is very simple: they may be strangulated with a ligature, as shown in the drawing; or they may be merely drawn out with the forceps and tied at the neck, and the bulk of the tumour removed at once below the place of the ligature—or, if the neck is small and situated high up, it will answer well to remove them by torsion and evulsion, as practised for similar affections of the nasal passages. Dupuytren excised them with the scissors; but this is a practice liable to be followed by internal hemorrhage, and much less safe than the ligature. If the tumour have a large base, a double ligature should be passed through its place of attachment, and each thread tied upon the corresponding half of the base, as in the removal of a large hemorrhoidal tumour.

In the case of a lady, whom I saw in consultation with Dr.

* The date of the first of the two operations performed by Dr. Ashmead, was antecedent to the first of the six which have been reported by M. Amussat. The results of this operation in the adult have been by no means flattering.

† Mémoire sur la Possibilité d'Etablir un Anus Artificielle, &c.

Sharpless, of this city, the polypous tumours had a strawberry aspect, somewhat resembling internal piles, and were attached by oblong flattened pedicles about three inches above the margin of the anus. There were several of these tumours with intermediate thickened bands forming a ring round the bowel and narrowing it so as to form a sort of supplementary sphincter through which the mucous membrane above, prolapsed. The case was one of great suffering, the tumours being exquisitely sensitive. I first nicked the thickened bands, at two opposite points with a blunt pointed tenotome, so as to be able to pass a speculum through the narrowed portion, and then strangulated the tumours in succession with the polypus instrument of Græfe described at p. 15. Very considerable relief was thus afforded the patient.

PROLAPSUS OF THE RECTUM.—PROLAPSUS ANI.

There are two varieties of this affection, which are not unfrequently confounded together:—1. That of simple relaxation of the mucous membrane at the lower end of the bowel, which protrudes through a relaxed or paralyzed sphincter (*prolapsus ani*). 2. That of the *inversion* and protrusion outwards of all the tunics of the rectum, and at times even of a part of the colon (*invagination with prolapsus*).

1. Of prolapsus of the mucous membrane.

In this affection the mucous membrane alone is everted in the form of a ring. It may project one or more inches beyond the margin of the anus in relaxed and feeble individuals, and especially in children who have suffered from irritation of the mucous membrane. The immediate cause of the protrusion is commonly the remaining long upon the feet, or making long-continued straining efforts at stool in the sitting posture. The mucous membrane near the anus is naturally everted in the act of defecation, as may be seen in some of the domestic animals, and returned again spontaneously by the elastic reaction of the cellular structure on its adherent face, aided by the contractile efforts of the sphincter muscle. When either of these parts loses its natural tone, the eversion becomes permanent, presenting a soft red annular tumour, but little painful on pressure, and which admits a finger to be readily passed through its central opening, but not upon its outer side where resistance is encountered from the sphincter muscle, the lining membrane of which is continuous with the mucous surface of the tumour. This serves as the diagnostic mark between this affection, and the invagination of the entire wall of the rectum in which a deep groove is left between the lining membrane of the sphincter and the protruded bowel. Prolapsus of the mucous membrane is in the adult very frequently found complicated with hemorrhoidal tumours, and is then usually curable only by the measures practised for the latter affection.

In simple prolapsus, while the membrane is yet readily returned by slight pressure, simple measures will often suffice for the cure; such as a well-regulated regimen, careful attention to the state of the bowels, the administration of bitters and tonics, frequent application to the parts of cold water, or astringent preparations, causing the child to go to stool in a semi-erect position, so as to retain, as pointed out by Dr. Physick, the supporting influence

of the glutei muscles on the sides of the perineum, or having the sides of the anus supported by the fingers of the nurse during the act of defecation. But in case these measures fail, the membrane—being allowed to remain permanently everted—from its exposure to the air, and to the contact with foreign substances, becomes tumefied, ulcerated, and bleeding—is returned with greater difficulty, and is sometimes found wholly irreducible, from the tightness with which the irritated sphincter embraces the protruded parts. But in most cases under these circumstances a return of the tumour may be effected, so as to palliate the patient's sufferings. It may be accomplished by inclining the body of the patient downwards, and making steady and uniform pressure with the fingers upon the tumour, which should be covered for the purpose with a piece of fine linen. In case the sphincter is found to offer great resistance, it might be divided as practised by Delpêch, with the knife, though I have never found such a measure necessary. By a compress and bandage, or a rectal truss, we may, in conjunction with the therapeutic treatment above mentioned, sometimes succeed in preventing the return of the protrusion. More positive measures will, however, be commonly required for this purpose. These consist—1, of the excision or cauterization of some folds of the lining membrane of the anus; 2, of the removal of the protruded portion by the ligature or with the knife, when it either cannot be returned or is so much altered in its character as to require excision.

Excision of radiated folds of the skin of the anus. (*Process of Hey and Dupuytren.*)—In the normal state the skin around this orifice is thrown into folds, which converge from the circumference to the centre of the opening. When the anus is excessively and habitually dilated, these folds become effaced in consequence of the impaired condition of the cellular and muscular structure below. The operation consists, as shown in Plate LXI. fig. 2, in grasping up flatwise these relaxed folds with a pair of good forceps, and snipping them away from the outer to the inner margin of the anus with a pair of scissors curved on the flat. Two, three, four, five, or six of the folds, according to the degree of relaxation, must be removed at different points of the opening. No hemorrhage is liable to follow, unless the operator should extend the incision too far in the direction of the bowel. No dressing was applied by Dupuytren. The cicatrization of these little wounds will usually be found to produce so much narrowing of the widened anus, as to prevent the recurrence of the prolapsus. To facilitate the performance of the operation, the patient should be placed on the abdomen, the pelvis rendered prominent by several pillows under the hypogastrium, and the thighs well separated by assistants.

Cauterization.—This is an old process, and but little practised, though it was revived by Sabatier, and has been latterly employed by Mr. Benj. Phillips. The patient is to be placed as directed in the operation just described, and directed to bear downwards so as to render the tumour as prominent as possible. The edge of the halbert-shaped cautery, heated to a white heat, is then to be drawn in a radiated direction over the tumour from the centre of the opening to the base of the fold, and at a number of points proportioned to the extent of the protrusion. The object to be accomplished in this operation is the same as in the excision of the folds of skin; but the pain, inflammation, and protracted sup-

puration, which follow the use of the iron, have caused it to be supplanted by the process just described.

Ligature.—When the prolapsus of the membrane is caused by a hemorrhoidal tumour, or becomes itself so prominent at various points as to admit of being raised up as separate tumours, the ligature may be employed with advantage, as in the ordinary operation for hemorrhoids.

Excision.—This process was successfully employed by Sabatier. He raised the hardened fold of the tumour with hooks or forceps, and excised its prominent portions with scissors curved on the flat. This operation is liable to be followed by hemorrhage, as the intestine is disposed to retract so as to render it difficult to secure the bleeding vessels.

Ricord (Pl. LXI. fig. 3.) has modified this process. He begins the operation by introducing two loops of thread through the base of the tumour, so as to prevent its too early retraction. He then with a bistoury makes a circular section of the ring of protruded mucous membrane, pausing to tie each artery as it is opened, so as to prevent the hemorrhage that would be likely to happen in case the part were removed at one sweep of the knife, and an attempt subsequently made to secure the vessels.

2. *Prolapsus of the rectum with invagination.*

This is a much more serious affection than the one just described. It is a case of intussusception not unfrequently observed in children, and occasionally in adults, in which the upper end of the rectum, or even the colon, may become inverted into the pouch of the rectum, and protrude externally through the orifice of the anus. Its development is usually accompanied with nausea, colic, and vomiting, after several attacks of which, the invagination of the bowel becomes, as the immediate consequence of any strong effort, or of straining at defecation, discoverable at the opening of the anus. It may form at the exterior a soft, round, cylindrical tumour, several inches in length, pierced at the extremity with an orifice through which a sound may be carried up into the bowel. Between it and the sphincter the finger may be freely passed, showing that the parts are merely contiguous.

The treatment consists in the reduction of the protruded parts by a sort of taxis, pressing with the finger so as to return first the parts last protruded, very much as in the reduction of a hernial tumour. If the parts can be returned within the orifice of the anus, they are to be retained by the use of a rectal truss, and the careful avoidance of all measures likely to reproduce the prolapsus. To be certain that the invagination of the bowel has been completely reduced, it will be well to follow the intestine up with a wax or gum elastic bougie, and leave the instrument for a few hours in the passage. It is sometimes found impossible in old cases of invagination to reduce the bowel, in consequence of the adhesions which have formed at the place of intussusception. In these cases nature sometimes effects a cure, by causing gangrene of the protruded part. An attempt to remove the projecting portions by operation which would involve the entire wall of the bowel, is not deemed justifiable, as the surgeon could not be assured that such adhesions had taken place as would prevent in his so doing the laying open of the peritoneal cavity of the abdomen.

CANCER OF THE RECTUM.—EXTIRPATION.

Cancerous disease is manifested in the rectum under various forms, and has not unfrequently been confounded with other affections, as simple hypertrophy or induration, which are much less serious in their nature. It may exist either as a primary affection, or be extended secondarily from the region of the anus, the vagina, or the uterus. It is usually of the scirrhus or colloid species, and is found very commonly unaccompanied with the general cancerous diathesis. The morbid matter may be effused into the substance of the bowel, causing either a local or general thickening of its parietes, or it may form a prominent tumour or a distinct ring round the bowel. The diseased structure usually terminates abruptly at its upper and lower borders, and it is only by examination with the finger that we are able to ascertain the nature of the affection. The effusion of morbid matter has a tendency to increase rapidly, to throw out projecting masses into the cavity of the gut, to ulcerate upon the surface, and finally, if the patient does not previously sink from constitutional irritation, to open the wall of the bowel and destroy him by the effusion of faecal matters into the cavity of the pelvis.

No disease is attended with more terrible suffering than this, which till lately was regarded as wholly incurable. The only means susceptible of affording any chance of relief, as shown by Lisfranc and Dieffenbach, is early extirpation. Simple tumours, especially if they are more or less pediculated, may be removed with a silk or wire ligature. The removal of a mass encircling the bowel—the common form in which the disease presents itself—is an operation of more serious import, and requires the use of cutting instruments. The two conditions necessary for the success of this operation, are, 1st, that the disease should be limited to the rectum, and not extend so far up but that the finger may be passed beyond it; for if it extend higher than this, there is great danger that it may have involved the uterus and ovaries if the patient be a female, or the peritoneal pouch which lies in front of the rectum in either sex: and 2d, that the surrounding cellular tissue be unaffected, so that the intestine may be readily drawn down. Should the entire substance of the parietes be involved, the case, according to Mr. Walsh,* is unfit for operation if the disease extend more than an inch above the anus. An inch and a half of the entire circumference is said, however, to have been successfully removed by Faget in 1839—defecation taking place readily and without pain in the new anus, which had been formed after the thorough removal of the sphincter; and Lisfranc and Dieffenbach assert that they have removed in several instances much more extensive portions of the bowel. It is well, however, to recollect that the peritoneum terminates in the male at the distance only of four inches from the anus, and at the distance of from five to six in the female. The rectum is so loosely attached by cellular tissue to the sacrum behind, and to the bladder, the prostate, and the urethra in front, that it may be readily separated with the finger, and drawn down when loosened by an oval incision at its inferior extremity.

“The merit of reviving this operation in the present century,” says Mr. Walshe, “rests with Lisfranc. Among nine operations of the kind performed by this surgeon before 1830, five termi-

* *Cyclopædia of Practical Surgery*, article Cancer.

nated by a cure; in one instance the issue was doubtful; three cases ended fatally. In two of the latter, purulent effusion in the pelvis, and phlebitis, were the causes of death; the body of the third subject was not opened. Mr. Mayo has also removed in one instance a portion of the entire cylinder of the rectum; the patient was exceedingly benefited by the operation; she had prolapsus afterwards, however, and died of inflammation in the abdomen two years after. It is indispensable for success that the limits of the disease be within easy reach of the finger (three inches have been removed), and that the surrounding cellular tissue be healthy, so as to permit the bowel to be drawn down with facility during the operation. Should the entire substance of the parietes be effected, the case is unfit for operation if the disease extend more than an inch above the anus.

"Velveau describes the steps of the operation as follows. The patient having been placed on his side, as in the operation for fistula in ano, with the thighs kept apart by a pillow and flexed at a right angle on the trunk, the anus is encompassed by two semilunar incisions joining anteriorly and posteriorly, and the resulting flaps dissected up to the edge of the sphincter. The left index finger is then introduced for the purpose of bringing down the diseased mass as low as possible, while an assistant draws the dissected ellipse of integuments in the same direction. The surgeon then cuts away the adhesions of the diseased gut by semicircular sweeps of the knife, and finishes by dividing the intestine transversely either with the bistoury or with curved scissors. When the cancer is deeply seated or extensively adherent, Lisfranc divides the posterior angle of the dissected ellipse with strong straight scissors, extending this division tolerably high along the rectum: the dissection is facilitated by an assistant drawing down the gut with hooks or strong forceps. The knife of the operator is guided by a finger in ano, and by the thumb placed on the external surface of the flap. One of the most important points to bear in mind, is the position of the hollow organs in front of the gut. Their situation may be marked by the finger of an assistant in the vagina, or by a sound in the male urethra; but these guides will be of little value unless the operator possess perfect anatomical knowledge. M. Costallat states that 'an autopsy which took place at the Venercal Hospital shows, that through the action of a cancer situated at the inferior part of the rectum, the *cul-de-sac* of the peritoneum may be brought within sixteen lines (Fr.) of the anus; whereas in the normal state, it is double or even treble as far from the orifice of the bowel.' This is an anatomical fact of most serious importance. The arteries should be tied when divided; when this precaution has been taken there is rarely any severe hemorrhage, or such as resists the application of lint steeped in cold water. A thick roll of shredded lint is introduced after the operation, and in order to prevent the tendency of the intestine to coarctation from becoming troublesome, the use of some contrivance of the kind should be persisted in for a time—say, a few weeks at least. The wound commences to contract from the fifteenth to the twentieth day,—the external and internal parts approximate, and eventually the visible loss of substance does not amount to more than an inch in width. The fibres of the levator ani, the aponeuroses and the end of the rectum form a sort of substitute for the sphincter: the patient, however, has commonly no control over liquid fæces, though the individual

operated upon by Faget could even retain flatus. Whatever may have been the success of Lisfranc, opinion is far from being strongly favourable to this operation, even in Paris: Amussat affirms that it 'rarely succeeds.' It may be observed, however, that the indication for removing a portion of the rectum obstructed by cancer is infinitely stronger than for the amputation of a cancerous breast. In both situations, it is true, the disease must destroy life, unless removed—but in the case of the rectum the free discharge of the function is demanded for daily existence. The comparative rarity of visceral contamination in rectal cancer, is a general argument in favour of excision.*

Process of Dieffenbach.—The patient is to be placed upon a table with the abdomen downwards, which should be well sustained with pillows, so as to render the anal region prominent. Two semicircular incisions are first made—one at the superior part of the anus, and the other upon the perineum. The finger is then introduced into the anus, to serve as a guide during the remainder of the operation, which is to be finished with the scissors. When he has penetrated to the depth of half an inch, he causes the buttocks to be separated by a couple of blunt hooks in the hands of an assistant. He next inserts a double hook into the inferior end of the rectum, and causes an assistant to draw the bowel down, as he detaches its connections cautiously with the scissors beyond the limits of the disease. By this method he has removed in one instance, two inches and a half of the rectum, and in another four inches; but in the latter he opened the cavity of the peritoneum—the patients in both cases finally recovering, according to the reporter of the cases.* The subsequent steps of the operation consisted in removing with the hand the fæcal accumulations in the bowel above the place of narrowing, washing out carefully the wound, and seizing the edge of the divided rectum with hooked forceps, after loosening it farther by dissection, and drawing it down to a level with the skin, to which, after being well opened, it was finally attached by suture, so as to form a new anus. By this modification of the operation of Lisfranc, the Berlin surgeon believes the patient is protected against the risk of excessive suppuration, and that contraction of the passage which would be liable to result from cicatrization, in case the intestine was not drawn down so as to have its mucous surface connected with the skin of the buttocks. The dressing consists in the application of compresses and masses of charpie steeped in cold water to the perineum and the margin of the new anus. The value of this bold method of operation is yet, however, to be decided.

There remains yet another mode of affording probable relief—that of the formation of an artificial anus, which has been referred to at page 300, in cases of desperate disease, where the rectum becomes thoroughly obstructed, "and symptoms of stercoral tympanitis and strangulation, with momentary risk of rupture of the intestines, have set in." "When the indications for performing this operation arise," says the author last quoted, "the patient should be allowed to choose for himself between certain death and the prospect of life with the inconveniences of an artificial anus, which the formation of such an opening affords. When the disease is cancerous, the chances of ultimate advantage are, of course, vastly less than in cases of retention from simple indu-

* Chirurgie de Dieffenbach, par C. Phillips: Berlin, 1840.

ration; but even here it may be justifiably performed, provided the patient, after having been made fully acquainted with the nature and likelihood of the benefit to follow, still desires to undergo it."

The mode of performing the several operations for the establishment of an artificial anus, has already been referred to under the head of "Imperforate anus."

HEMORRHOIDAL TUMOURS, OR PILES.

Tumours of very various appearances have been described under the name of *hemorrhoidal tumours* or *piles*—different writers taking unfortunately some particular variety as the peculiar type of the affection, so as to render the pathological anatomy of this very common disease confused and imprecise. It may suffice in this place to state, that the substantive disease in a hemorrhoidal affection from whatever cause produced, is the determination of blood to the mucous membrane of the lower extremity of the rectum. This, if not checked in its early and forming stages, as it readily may be by proper regimen, and therapeutical applications, gives rise in the end to submucous inflammation, thickening of the tissues by the deposit of lymph, to the varicose enlargement and dilatation of the vessels of the part, to the eversion of thickened folds of the mucous membrane, &c. &c., so that when the disease is allowed to run on uninterruptedly, it may in different individuals present in either one of the following forms, under which they have been considered by Professor Warren.*

"1st. An internal tumour; 2d, a tumour occasionally appearing without the anus; and, 3d, a tumour permanently external. The first two are arterial tumours of the mucous membrane, and differ only in degree. The third is an enlargement of the veins of the rectum, with an intermixture of small arterial vessels.

"The internal tumour is often formed long before its existence is known. The first evidence of it is a moderate discharge of blood with the evacuations, and without pain. On examining by the finger, in the early stage, it is difficult to detect an alteration from the ordinary state. By the speculum, we discover an unusual redness, with an appearance of a vertical fold of the membrane.

"If the disease continues, the mucous membrane becomes swollen and elongated, protrudes beyond the anus when the rectum is evacuated, and forms a red tumour—usually retiring, in a short time, into the cavity of the rectum, especially after a discharge of blood, which relieves the swelling. In this way is generated the second form of the disease, which is much more troublesome than the first; for the tumour is, at length, difficult to return, and while it remains out, being pinched by the sphincter muscle, gives great pain and uneasiness in sitting and moving. The vascular organization of the rectum, and the loose cellular connection between the mucous and sub-mucous coat, allow the extension of the tumour to the circumference of the rectum; and, at length, a circular portion of the membrane is protruded, and constitutes prolapsus ani. This state of the complaint is formidable. The difficulty of returning the swelling is greater, the consequent pain is now more distressing, and the hemorrhage

considerable. The blood is thrown out at the time of evacuation in a gush, sometimes to the amount of a gill or more at one time.—The patient becomes much reduced by this constant discharge of blood, and, if it continues, may at length sink under it. This result, however, rarely occurs, unless he has neglected the proper means of relief.—The tumour formed in prolapsus, in many persons, becomes indurated after a time. Then the copious discharge of blood is prevented by the pressure on the vessels made by the indurated substance. But in this case, an evil arises scarcely less annoying. The tumour descends in the common movements of the body, so that the patient is unable to walk without bringing it down; and the consequence is, that he is obliged to wear a bandage, acting like a truss, to retain the swelling in its place.

"The third and most common form is the external tumour, known by the name of piles. This is originally a swelling of the hemorrhoidal veins, covered by the extreme verge of the mucous membrane, and by the skin connected with it. It is, at first, a soft compressible tumour. By times, it becomes hard, and forms one or more nipple-like eminences about the anus. In its early stage, it is of a blue colour, like other venous tumours. As the skin over it thickens, and the veins harden, their cavity is diminished, the blue colour disappears, and they assume the colour of the skin of the part.

"The causes of these different forms of affection are of the same nature. They are either such as, by compressing the hemorrhoidal veins, prevent a free return of blood from them, or such as, by over-exciting the vessels of the rectum, produce accumulations of blood in the small arteries. Among the former are costiveness and pregnancy; and of the latter, dysentery, and the continued use of strong cathartic medicines."

The internal hemorrhoidal tumours sometimes come down so as to be strangulated by the sphincter muscle, and give rise to extreme local suffering and much sympathetic disturbance. They are to be carefully returned into the abdomen by the same measures as are resorted to for the return of the prolapsed bowel. In case this should be found difficult, from the great sensitiveness of the inflamed and protruded tumour, or from the spasm of the sphincter, the parts should be previously well fomented or covered with warm poultices.

The curative treatment of hemorrhoidal tumours is divided into the medical and surgical. Of the latter only, as coming within the scope of this work, we shall here treat—premising first, that no operation is to be undertaken during what is called a *fit of the piles*, the consequence of temporary inflammation and tumefaction of the parts, but only after the symptoms have been relieved by appropriate therapeutical applications. There are three methods of operation employed in the removal of these tumours—*incision*, *ligature*, and *excision*.

Incision.

This is applicable only to that form of external piles in which the tumours are seated at the outer margin of the anus, covered partly by skin and partly by mucous membrane thickened by inflammation, and containing in their interior an oblong or rounded mass of clotted blood, lodged in the dilated extremity of a hemorrhoidal vein, or in the cellular tissue of the part. The colour of the clotted blood is obvious frequently through the skin, and gives

* Surgical Observations on Tumours, by J. C. Warren, M. D., Prof. of Anat. and Surg. in Harvard University: Boston, 1837: pp. 453-456.

a bluish grape-like appearance to the tumours. The operation for their cure is very simple. An incision is to be made through the thickness of the tumour with a lancet or common bistoury, and the little mass of clotted blood turned out. Simple dressing, with careful ablution of the part from time to time, is usually all that is required for the cure. If the little wounds are slow in cicatrization, or become troublesome from their itching, the tannin ointment, or a wash of lunar caustic, or some astringent lotion, may be employed with advantage.

In chronic cases, where the clotted blood in these grape-like tumours has been removed by absorption, the skin presents merely a prominent thickened fold, and if found subject to occasional inflammation, should be extirpated with the knife or scissors.

Ligature and Excision.

The process by ligature is particularly applicable to all spongy and vascular tumours of the rectum, especially if they are connected to the surface of the bowel by a base of considerable size. Some surgeons employ it even in all cases of internal piles, as it effectually prevents hemorrhage—a result especially to be dreaded in vascular tumours, inasmuch as the bleeding, which may take place internally, and distend the rectum and colon without showing itself without, has in some instances proved fatal. But if the tumours have lost their vascular character, become hard from the interstitial effusion of lymph, and are pedunculated, they may be snipped off at their root with perfect safety. And it is to cases of this description, and to tumours rendered so far external, that such vessels as bleed, may be secured with ligatures or obliterated with the heated iron, that the author believes it most safe to restrict the operation by excision. The excision of hemorrhoidal tumours is, however, the common rule of practice at the present day among French surgeons, though it has been lately strenuously opposed by M. Mayor, of Lausanne. For either mode of operation, it is necessary to have the bowels previously well evacuated by the administration of a mild cathartic or an enema. It will be necessary, moreover, in most instances, for the patient to seat himself over a vessel of warm water, so that he may protrude the tumours, and make them more accessible to the surgeon. He may be placed for either process upon the side, with the buttocks projecting over the margin or foot of a bed, or made to lean upon the abdomen over the side of a bed, the back of a sofa or chair.

It has been proposed (and latterly carried into practice by M. Chauvet, of Bordeaux), to divide the posterior commissure of the sphincter backwards to the point of the os coccygis, in order to get a large dilatable orifice so as to reach the tumours, situated high in the rectum, as well as those having a lower site which cannot be protruded or drawn without.

Ligature.

There are two modes of effecting strangulation—with a wire ligature and the double canula of Levret, and with the ordinary waxed silken or hempen thread—the tumour being in both cases returned within the ring of the anus.

With the wire ligature and double canula. (Process of Dr. Physick.)—This is a process formerly much employed in this country, and still used to a considerable extent, though it has fallen latterly into much disfavour, in consequence of the severe pain which

attends its application, the occasional development of symptoms that for a time simulate those of strangulated hernia, and the necessity of leaving the wire and canula—a separate instrument having to be employed for each large distinct hemorrhoidal tumour—dangling for a series of hours together at the margin of the anus.

The wire should be of iron and well annealed, and the canula not more than two inches in length. The loop of the wire is to be slid over the free portion of the tumour up to its neck, and drawn as tightly as possible with a pair of dressing forceps, with a view of cutting off the circulation of blood to the tumour, and lessening the amount of pain, which would be wholly unendurable if the strangulation was incompletely effected so as to allow the tumour to inflame and swell over the ligature. The free end of the wire is then to be secured to the arm of the canula as described at page 14. When there are several tumours, the larger ones only are to be strangulated in this manner. The removal of a single one it is said has proved sufficient to cause the disappearance of the rest, the inflammation developed by the operation blocking up their spongy structure by an effusion of lymph. This is a result, however, which by no means always follows. At the end of twelve or twenty-four hours, the wire is to be unwound from the arm and pressed through the canula, so as to enlarge its loop and allow of its being withdrawn over the tumour. Each of the tumours strangulated, will be found insensitive, shriveled, and dark-coloured. Poultices are to be applied to the parts. The tumours in a few days—from four to six—separate by a sloughing process at the part where they have been pinched by the wire.

The great improvement suggested by Dr. Physick in the use of the ligature, consists mainly in its removal before the fall of the tumour, up to which period it was left by the older surgeons.

Ligature with the ordinary silk or hempen thread.—This process consists merely in grasping the tumours with a thumb and finger or a pair of forceps, and surrounding them as tightly as possible with a thread, returning the tumour again into the cavity of the bowel. The thread has to be left till the tumour sloughs off, as the swelling of the structures which follows, as well as the augmented irritability of the parts, renders it impossible to reach it with the knife. This process, which is in common use with many surgeons, is decidedly inferior to the one just noticed, for although the patient is not left encumbered with a pendent canula, it is difficult to effect thorough strangulation with the thread, even when it is passed double with the needle through the pedicle of the tumour and tied on either side. In consequence of this and the necessary retention of the thread for several days together, the patient is kept in a constant state of suffering, aggravated to an almost insupportable amount at the periods of defecation, when the tumour is made to drag upon its inflamed and partially detached neck. The plan which the author has found decidedly preferable to either of these, and which is in common use among many surgeons, is the combination of the

Ligature with excision.—After tying the neck of the tumour, when this is pedunculated, in the manner above mentioned, the protuberant portion is to be excised with a pair of scissors curved on the flat, just in advance of the ligature. All the tumours, even if they are as many as five or six in number, are to be raised, or if necessary drawn down with the forceps, tied, and removed. When the pedicle is not very narrow, the author prefers always

to pass the ligature double, with a needle and a thread on either side, in order to prevent with certainty any displacement of the ligature for two or three days, by giving it a hold upon the parts. In case there is difficulty in reaching the tumour, the author has pressure made with the fingers of an assistant on the sides of the sphincter, so as to invert the lower end of the gut; and if by this means the root of the tumour or the base of the prolapsed and thickened folds of the mucous membrane, which sometimes alone constitute the offending body, cannot be brought fairly to the surface, he passes a double ligature with the apparatus devised by the late Mr. Bushe.* This consists of a small curved needle threaded near its point with a double waxed thread, and inserted into a groove at the end of a needle-carrier, which is bent somewhat like the common aneurismal needle. The tumour is to be raised and drawn slightly downwards with a pair of toothed forceps; the armed needle-carrier is then passed into the orifice and the needle brought downwards again so as to pierce the base of the fold of membrane or the broad attachment of the tumour, and present its point without. The needle is next grasped with a pair of ring-pointed forceps, loosened from the needle-carrier, and withdrawn. The loop of thread is then to be cut, the ligatures tied upon either side of the neck, and the tumour excised with the scissors. This apparatus of Bushe will be found most convenient in many cases of disease where the thickened and vascular membrane presents no round and prominent tumour that could be grasped with the wire loop. The elevated folds at the margin of the anus should also be removed by simple excision, so as to leave none of the parts which when inflamed had previously occasioned the *fits of piles*, to be affected by the inflammation which to more or less extent must necessarily follow the removal of the tumours. Each of the ligatures applied upon the tumours is to be cut off close to the knot. The protruded parts are to be carefully returned within the sphincter. Warm fomentations are to be applied upon the anus and perineum. The patient should be placed under the influence of morphia, and take from time to time copious draughts of some mucilaginous preparation conjoined with drachm doses of the sp. ether. nitrosi, in order to diminish the tendency to retention of urine which now and then takes place, especially when the seat of the tumour is on the side of the bowel next the bladder. On the third day the bowels are to be moved by an oleaginous enema; and with the feculent matters the threads which have been applied to suppress the bleeding will commonly be discharged.

I have no hesitation in recommending this mode of managing hemorrhoidal tumours, as I have practised it at least thirty times within the last five or six years, frequently with but very little suffering to the individual, and in every instance without any bad consequences. The cicatrization of the raw surfaces left will sometimes demand the use of astringent washes or ointment, or the injection of a solution of lunar caustic, as well as careful regulation of the regimen.

Professor Horner† has suggested the following modification of the use of the wire ligature. Having made the usual preparatory measures, and caused the patient to protrude the piles, he is laid on the side corresponding with the tumour, and near the edge of the bed. "A thick sail needle armed with a large ligature, is

then passed transversely through the upper part of the base of the tumour; the needle being removed from the ligature, the two ends of the latter are tied together, so as to form a loop. A stout awl then transfixes the lower part of the base of the tumour in a line parallel with the ligature above.

"In a large protruded pile, the usual anal pouches or sacs are much enlarged, and have their orifices pointing downwards. The awl, when placed as intended, is between these sacs and the adjoining margin of the anus, and makes the part so firm, that it is more easily operated on subsequently. The inferior third of the base of the tumour is now detached from the anus with a scalpel, the anal sacs, and a corresponding loose fold of skin which commonly exists at the same time with large hemorrhoids, going along with the tumour. Should the tumour recede, the loop above, and the awl below, enable the operator to draw it out. A wire noose is then thrown round the adherent base of the tumour, and drawn perfectly tight, by the aid of a double canula. This noose occupies the previous incision, and it may be placed with great accuracy, from the command of the pile derived from the first ligature and the awl.

"The tumour, if very large, may now be punctured so as to disgorge its blood. At the end of five hours, the part is perfectly dead by strangulation, the tumour may then be cut off near the wire noose, say three lines from it, for which act in the process of operating, a pair of scissors will do; but what is still better, Dr. Physick's tonsil instrument, owing to the accuracy of its line of incision. The wire noose itself may then be taken away, as the vessels are so compressed and deadened, that no blood will pass through them.

"The awl should be removed directly after the wire noose is applied and fixed, but the first loop should be retained for the final act, to wit: the excision of the tumour, as it assists very much. The operation thus completed, an injection of tinct. opii $\mathfrak{z}\text{i}$ in two ounces of thin starch, puts the patient at ease, and he falls into a tranquil sleep."

Excision.

Process of Professor Warren.—"The parts, being sufficiently protruded, are to be seized by a double-pointed forceps, drawn down sufficiently to give tension to the membrane, and then, with one or two strokes of a round-edged dissecting knife, the tumour removed. If there are tumours on both sides, as commonly there are, the same is to be done on the opposite side; and the co-existing external piles are to be excised in the same way. It is necessary to avoid taking off a circular piece of the anus, as this is apt to be followed by a contraction which may require another operation. The patient should be carefully watched for three or four hours; and if he has an inclination to stool, let him indulge it, and he will probably discharge a large quantity of blood showing that an internal hemorrhage has been going on. Fainting at the distance of half an hour or more after the operation, indicates bleeding. In both of these cases, the introduction of sponge will be required. For this purpose, take a piece of sponge, of cylindrical form, two inches long, and an inch in diameter. Pass a thread through one end of it, and then introduce it so far that it shall scarcely appear externally. This I have never known to fail of checking the hemorrhage. When there is no dangerous bleed-

* Bushe on the Diseases of the Rectum. New York.

† Am. Journ. of Med. Sci., Oct., 1842.

ing, so that the sponge is not necessary, a piece of oiled lint should be introduced to separate the opposite parts of the anus.

"The patient should be kept in the horizontal posture a longer or shorter time, according to the degree of disease under which he has laboured; for although no confinement is required by the operation itself, it is proper to aid it by giving the affected vessels time to contract. In none of these cases are all the disordered parts excised, so that we must trust much to the salutary operation of nature to finish the cure, and must allow opportunity to perform her work unembarrassed by the movements of the body.—The most annoying symptom after this operation, arises from the effort of the intestines to expel their flatus. When the impulse thus given reaches the wounded part, it brings on a spasmodic contraction of the sphincter, which is excessively painful. The flatus is resisted, and driven back into the colon, and accumulates to a distressing amount. The interposition of the oiled lint commonly allows the flatus to pass down. When it fails to do so, the patient must submit to the use of a mild injection, which, however painful to the wounded part, soon affords relief. Sometimes it becomes necessary to remove these contractions by the use of opium.—On the third day a cathartic of castor oil is administered; and this, with bathing the part daily with warm water, and applying some unctuous substance, is all the treatment required."

Dupuytren simply raised the internal tumours with the forceps, and excised them with scissors curved on the flat. In case there was any tendency to hemorrhage, he immediately touched the bleeding surface with the actual cautery. This, however, it is not always easy to accomplish, especially when the bowel has retracted, and it becomes necessary to make it again protrude. In one instance, in which hemorrhage followed the removal of a tumour by this process, I succeeded in transfixing the bleeding surface with a couple of hare-lip pins, and securing it with a ligature.

Baron Boyer, when the tumours were distinct and separate, raised them with hooks, or with a loop of ligature passed through the base of each with a needle. These were held by assistants, in order to prevent the retraction of the parts before the process of excision was completed. When the protrusion was in the form of a circular rim with irregular depressions, he passed the loops at the base of the several prominent points. Taking each loop in succession in his left hand, he then excised the tumours one after another with the bistoury, laying the instrument with the back towards the bowel and cutting outwards. A mesh was then introduced into the bowel, consisting of many portions of charpie doubled at their middle for the purpose of making pressure on the bleeding vessels, and preventing a contraction of the parts during the process of cicatrization. A pad of charpie pressed strongly up upon the anus with a T bandage, completed the dressing. There would still, however, even with this precaution, be a risk of internal hemorrhage that might endanger the patient's life, and render necessary a more thorough tamponing of the rectum, or the application of the ligature or the actual cautery.

Velpéau, for the purpose of preventing hemorrhage, inflammation, and the risk of purulent absorption, has proposed to traverse the root of each tumour with several ligatures, and in front of these remove the tumour with the bistoury or scissors, subsequently knotting the threads so as to close the wound.

The author, when the tumours were external, has employed this process with advantage in two cases, in one of which the wound left after the excision of a large tumour, healed up by the first intention.

Lisfranc causes the mucous membrane and the tumours which stud it, to descend as far as possible by gentle traction with the fingers. He then seizes the circular fold between the thumb and finger of the left hand, and makes a vertical incision through it with the scissors. An assistant now grasps in the same manner the opposite side of the vertical cut, and the surgeon shaves off horizontally the projecting portion of the fold, stopping as the divided vessels spring to twist or tie them effectually. He continues the incision in this way to the opposite extremity of the circle, and before he makes the final incision to detach the piece, surrounds the narrow attachment left with a ligature, if it be found on examination to contain pulsating vessels. No dressing is required, except the occasional introduction of the finger after the fifth or sixth day, to prevent any vicious adhesions. According to *Lisfranc*, this process has in thirty cases been unaccompanied by hemorrhage.

ABSCESS BY THE SIDE OF THE ANUS.

From the abundance and vascularity of its surrounding cellular tissue, from the absence of valves in its veins which are placed at the lowest point of the portal system, and from its intimate sympathy with the genito-urinary organs, the anal region is particularly prone to congestion, inflammation, and abscess. Abscesses of the anus may for practical purposes be divided into the deep-seated and the superficial, the former of which are alone of very serious import. The distinction between them is not usually difficult. The superficial abscess is readily known by its prominent pouting form, and by the shortness of the period in which the fluctuation of pus becomes manifest. In sensitive subjects, however, even small superficial deposits of pus may produce symptomatic disturbances of the prostate, urethra, and bladder, so as to render the diagnosis more obscure. Abscess of the anus rarely terminates without an opening through the skin, or into the anus. The faecal odour of the pus is no undeniable proof of the opening into the rectum, for it may be transmitted through the thinned mucous membrane. Though it is nearly impossible to effect the resolution of the inflammation and hardening of the cellular tissue by the side of the anus, the extent of the suppuration may be limited by judicious therapeutical treatment. As a general rule the superficial abscess should be opened at the first appearance of fluctuation. An early and prompt incision is still more strongly indicated in the deep-seated. The author has found it advantageous to lay freely open with a curved sharp-pointed bistoury the thickened and hardened mass before it runs on to suppuration, thereby facilitating the process of cure, and diminishing greatly the risk of the establishment of burrowing passages round the rectum, or the formation of an anal fistula.

FISTULA IN ANO.

The pathology of anal fistula is closely connected with that of abscess of the anus, when this, from whatever cause produced,

has become chronic and fistulous. If a fistulous abscess by the side of the anus communicates by one or more orifices internally with the rectum, and opens at the same time externally through the skin, it constitutes a complete anal fistula. If there is only one opening, it is called incomplete or blind; if that opening is internal only, it is called a blind internal fistula: if external, it is a blind external fistula.

Complete Anal Fistula.

In the greater number of cases there is but one internal opening, and that at a distance of less than an inch from the margin of the anus, formed—through the substance of the external sphincter—in the cellular interstice between the internal and external sphincter muscles—or through the walls of the bowel and the lower edge of the levator ani muscle at some distance above the sphincter. In some cases (and especially in phthisical subjects in which no operation is considered proper), more than one opening may be found, and occasionally at the distance of two or three inches from the anus, as in the case of which a drawing has been given by Matthew Baillie. According to the statement of M. Velpeau, of thirty-five cases of complete fistula, which he examined in 1833, the internal orifice was found in thirty a few lines only from the margin of the anus, and in the remaining five at the respective distances of an inch and a half, two inches, two inches and a half, and three inches above the anal orifice. The external fistulous opening is commonly found at some part of the outer circumference of the anal opening, though it may exist at any portion of the structure of the perineum, between the margin of the buttocks of either side, or between the os coccygis and the bulb of the urethra. There may be several external orifices, the sinuses of which communicate with one another through a mass of hardened tissue, so as to render their exploration by no means easy. The internal orifice can frequently be seen on the eversion of the edges of the anus, or may be felt by a finger introduced into the anus, or rendered manifest by a probe introduced from the external opening and pushed obliquely in towards the bowel.

In sounding with the probe I have seen again and again erroneous deductions drawn as to the depth of the fistulous passage, from the introduction of the instrument in a direction nearly parallel with the bowel; for the cellular and fatty tissue on the outer side of the rectum is so soft and yielding, even in its healthy state, as to render but little resistance to the passage of the probe to the extent of three or four inches between the levator ani and the obturator muscles. In some instances we find merely the mucous membrane, detached by the fistulous pouch from the other tunics of the rectum.

Treatment.—The indications to be fulfilled are the laying open of the fistulous tracts, and the division of the sphincter muscle, which dams up the fæcal matter, turns it into the cavity of the abscess, and keeps up such frequent motion of the parts as to prevent the tendency to heal. The division of the sphincter is considered by Sir Benjamin Brodie so necessary to the cure, that he effects it even if necessary from within outwards with the knife, when the internal fistulous orifice is found below its upper border. The division of the sphincter and the callous tracts is made either by incision or ligature.

Incision.—This operation is exceedingly simple, though a variety

of instruments have been devised for its performance. In a great majority of cases a narrow probe-pointed bistoury is all that will be required. The patient is to be placed in the usual position for operations on this region. The fore finger of one hand, oiled, is to be introduced into the bowel, with the pulpy portion turned to the fistulous orifice; with the other the bistoury is to be gently introduced from the external orifice till the probe point is felt in the bowel, and can be covered with the finger over its back. A double motion is now given to the bistoury. The point is drawn outwards with the finger, while the blade is slid on with the other hand so as to cut out by a sliding stroke. All the various superficial fistulous passages are to be laid open so that they may be dressed from their bottom and solidly closed up by granulation. If the skin from the extent of the abscess is rendered shelving, callous, and dark-coloured, the angles formed by the incisions may with advantage be snipped away. If there are several internal orifices opening above the sphincter, it does not, according to the observation of the author, answer to divide the muscle at more than two points, for fear of too much diminishing the resistance which the sphincter is intended to make against the retraction of the levator ani. Two instances have come under my notice where the sphincter had been divided at three or four different points, in which, after the healing of the fistula, the divided portions of the muscle and the skin of the anus were drawn up by the levator, so as to destroy the action of the sphincter. The division of the sphincter should, if possible, always be made upon the side, as we thereby more completely produce a temporary loss of function in the muscle, than if the incision were made at its coccygeal or perineal points. A single thin mesh of greased lint or linen pushed gently into the bottom of the wound with the end of the finger or a spatula, is all the dressing that is required. In case much bleeding should follow, it may be necessary to tampon the rectum, and apply cold lotions, and, in some instances even, to tie the bleeding vessels.

Incision on the gorgeret.—Pott introduced a piece of hard wood, concave upon one side and convex on the other, (called a *gorgeret*,) into the rectum; he then passed a grooved director from the external orifice down the sinus, and along this slid a sharp-pointed bistoury, with which the parts including the sphincter were divided from within outwards upon the groove of the gorgeret, which should be steadied with the other hand. This process is still employed by many surgeons, and the author has found it advantageous in cases where—from the callousness of the structure, the winding track of the sinus, or the unusual height at which it terminates—it has proved difficult to find the internal orifice. In many cases it will suffice to introduce the narrow-bladed knife without the use of the director.

By ligature.—This, which is an ancient practice, was warmly advocated by Desault. It consists in passing through the track of the sinus, a bent eyed probe threaded with a waxed thread, or a leaden wire, along the groove of the director, or the canula of a trocar; or the ligature may be passed with some one of the instruments especially devised for this purpose. The inner end of the ligature is then to be brought out from the orifice of the anus, and the two ends loosely tied or twisted together over the external surface, (which should be protected by a pledget of lint,) so as to include the sphincter. The ligature is to be tight-

ened anew every second or third day, until the parts are fairly cut through. In some cases the track cut by the ligature heals up by granulation as the ligature makes its way to the surface. This is a result, however, which by no means always follows; not unfrequently, and especially in subjects of bad habits of body—those most subject to this affection—the ligature acts as a foreign substance, keeping up constant irritation and pain, and causing offensive discharges from the rectum and extensive suppurative inflammation in the cellular tissue round the anus. It is a protracted process, requiring to effect a cure from four, five, or six weeks, to as many months. It does not necessarily cause the patient to lay by, and this, with the avoidance of all risk of hemorrhage which might attend the cure by incision in cases where the fistula opened high up in the bowel, or was accompanied with great hemorrhoidal enlargement of the veins, are the only features to recommend its employment.

Mr. Luke, who has recently written in praise of this process,* attaches the ends of the ligature to a small fistula tourniquet, and keeps up the requisite amount of tension, by turning the screw from time to time, as the thread becomes loose.

Compression has of late been resorted to for the cure of anal fistula, but with little success. It is effected by means of a double cylinder introduced up the rectum—the outer cylinder serving to compress the wall of the bowel against the track of the sinus so as to prevent the passage of the fecal matter through it; the inner cylinder serving merely as a stop, to be temporarily withdrawn for the purpose of defecation.

Incomplete External Fistula.

This is but a chronic abscess by the side of the rectum, rendered fistulous, and kept from healing by the action of the sphincter muscle. The only peculiarity of treatment it requires arises from there being no internal orifice, and the necessity of making one so as to convert it into a complete fistula, like which it is then to be treated. The puncture is to be made at a part where, on the introduction of a finger, the wall of the bowel is found most thin and yielding. The sheathed bistoury of Physiek, or the bistoury of Cruikshank provided with a stilet at the end, has been employed for this purpose. In my own practice I never find it necessary to employ any other than an ordinary narrow, but strong, curved probe-pointed bistoury, with half the probe point ground away so that it may be made to cut through the coats of the rectum upon the finger—the point of the instrument remaining sufficiently blunt to protect the finger from injury when it is covered by the latter during the division of the bridge of soft parts. In case of need, the division may be effected with the gorgeret and sharp-pointed bistoury as above described.

Incomplete Internal Fistula.

This form is more rarely met with. It is usually the result of an ulcer of the bowel, occasioned by the suppuration of a hemorrhoidal tumour, or by the irritation arising from the lodgment of some foreign substance. Fæcal matters are apt to escape under such circumstances into the cavity of the sinus, and convert it into a stercoraceous abscess. If the fluctuation can be felt from

without, it is to be converted into a complete fistula by a puncture through the skin. If the pus is discharged so freely into the gut as not to be felt externally, a bent probe is to be inserted through the orifice of communication with the bowel. The end of the probe when detected from the skin is to be cut down upon with the bistoury. The treatment subsequently becomes the same as in complete fistula.

In one instance of large stercoraceous abscess which occurred in a patient with a vitiated constitution, crepitant on pressure, and exhaling a gangrenous odour, I succeeded in effecting a cure by a single free application of the actual cautery. The change of structure effected by the iron obliterated the sinus which led to the bowel, leaving an ordinary abscess which permanently closed in three weeks.

Enlargement of the mucous sacs.—The small semilunar sacs formed at the termination of the mucous membrane of the rectum, are, as first noticed by Dr. Physiek, sometimes so enlarged by disease as to be the source of much suffering or annoyance. These pouches open upwards, and when enlarged and viewed from below, present at times the appearance of vascular tumours. A small probe, bent at the end, is to be hooked from above into the cavity of each one in succession, so as to render its wall prominent, and allow of its being clipped away with the scissors.

FISSURE OF THE ANUS.

This affection is less frequently observed in this country than in those where the use of elysters is more habitual. It is mostly complicated with spasm of the sphincter, and then causes the most excruciating pain during defecation. When observed as the consequence of syphilis it is less painful and serious, and is known under the name of *rhagades ani*.

Simple chaps, involving only the skin around the anus without extending into the mucous membrane, or exciting spasm of the sphincter, may be cured readily by appropriate topical treatment like other unhealthy sores. But when the fissure is accompanied habitually with severe spasm, the division of the sphincter muscle, which should be held as a last resource, is the only measure that will afford relief. It is to be made with the bistoury, which should be carried directly through the fissure so as to convert it into an open wound. If the muscle is divided at another point, as some have directed, though the spasm may be relieved, the fissure will be little disposed to heal without the repeated use of caustic.

STRICTURE OF THE ANUS.

This occasionally occurs in consequence of the cicatrices and indurations following operations on this region, or from rigidity of the sphincter muscle, and often precedes the formation of fissures. If not extreme, relief may be derived from the habitual use of laxatives, and the introduction of steel bougies, the size of which should be gradually augmented till a permanent dilatation is effected. If the stricture is more completely formed, it may be necessary to make some incisions at the margin of the anus with a bistoury, or to divide the sphincter muscle.

* London Lancet, Feb. 22, 1845.

IX. OPERATIONS UPON THE GENITO-URINARY ORGANS.

IN THE MALE.

The operations described under this head consist of those practised—1. On the Scrotum; 2. On the Penis; and 3. Those on the Urethra and Bladder, including the operations for stone.

OPERATIONS UPON THE SCROTUM.

These comprise operations for Hydrocele, Sarcocoele, and Varicocele.

HYDROCELE.

This term signifies a tumour formed by a collection of water in the cavity of the tunica vaginalis testis, or in one or more serous cysts placed along the cord, between the testicle and the external inguinal ring. Simple œdema of the subcutaneous cellular tissue of the scrotum, in consequence of its occasionally forming a large pallid tumour, is sometimes designated as *hydrocele by infiltration*. The first two varieties alone, as requiring particular treatment, will be considered here.

Hydrocele of the Tunica Vaginalis Testis.

This is the most common form of the affection. The more characteristic symptoms by which it may be distinguished from other tumours of this region, are its fluctuation, its transparency, the permanency of the swelling, and the progressiveness of its development from the bottom of the scrotum upwards. An effusion of serum into the vaginal tunic, arising as an epiphenomenon in orchitis, has been denominated *acute hydrocele*, and usually disappears under the treatment calculated to dissipate the enlargement of the gland.

In the *chronic form of hydrocele* there is little prospect of relief except by operation. The amount of fluid collected will be found to vary according to the size of the tumour, from a few ounces to several pints. Mr. Cline is said to have removed six quarts from Gibbon, the historian, at a single operation. Chronic hydrocele may be complicated with several affections, rendering particular attention necessary in reference to the diagnosis. If the testis is found enlarged, either as the cause, the consequence, or an attendant upon the effusion, the tumour is denominated *hydro-sarcocoele*. If the collection of fluid is complicated with a hernial tumour, it is denominated an *oscheo-hydrocele*, the sac of water lying mostly to the outer side of the hernial protrusion. A distinction of much practical importance is made between the hydrocele of the adult, and the congenital form of hydrocele which occurs in the child before the peritoneal orifice of the vaginal tunic has been obliterated.

Operations for hydrocele of the adult.—These are divided into two classes—the *palliative*, which consists merely in the evacuation of the fluid, and the *curative*, which comprises the several methods by incision, excision, introduction of the seton or other foreign bodies, and the injection of some stimulating liquid.

Palliative cure.

Evacuation of the fluid by puncture with a trocar. (Pl. LXII. fig. 1.)—The patient is to be seated on the side of his bed. The surgeon determines carefully the position of the testicle, which may be detected either by the peculiar sensation it gives the patient, when pressed with the finger, or by its appearing as an opaque mass on examination in a darkened room, with a candle held on the opposite side from which the organ is viewed. This is a step which should not be neglected; for I have several times, as in a case upon which I recently operated at the Philadelphia Hospital, found the testicle lying at the front and inner side of the vaginal tunic, and liable to have been injured in the operation if its unusual position had not been detected. The scrotum is to be grasped with the left hand as shown in the drawing, so as to render the integuments tense, and press the testicle out of the way, and the trocar entered at the middle front part of the tumour in such a direction as not to strike the gland. The stilet is then to be withdrawn and the fluid evacuated through the canula. Some direct the insertion of the trocar at the lower part of the tumour; but I find this a less eligible position in consequence of the contraction of the scrotum, which follows the escape of the fluid, rendering the direction of the instrument so oblique as to increase the risk of its slipping out from the vaginal sac into the surrounding cellular tissue, a result particularly to be avoided when it is the intention to follow up the puncture by the process of injection. The fluid is nearly always reproduced, so as to render the repetition of the puncture necessary every four, five, or six months—and it is merely from the temporary relief afforded that the term *palliative* has been applied to this method of treatment. It is seldom, therefore, to be trusted to except in cases of children, where there is more reason to expect from it a permanent cure—or in the very large hydrocele of old men, where the fluid is found of a chocolate colour, and the vaginal tunic has undergone such pathological alteration as to render any of the more irritating methods for the radical cure liable to be followed by extensive suppuration and acute œdema of the scrotum. In the large hydrocele of old men whose constitutions have been much broken up, simple puncture has in some instances been followed by sloughing and abscess. In making the puncture it is necessary to avoid the course of the large veins of the scrotum, and the arterial branches when these are so large as to be felt pulsating. I saw, a few years ago, in consultation with Dr. Rutter, of this city, an old gentleman who was in the habit of tapping himself with a lancet. He had performed the operation a hundred and thirteen times in the course of some years, but finally, on introducing the lancet in a transverse direction, divided the spermatic artery. Profuse hemorrhage followed, which filled up the cavity of the vaginal tunic, converting it into an hæmatocele, and injected the subcutaneous cellular tissue of the scrotum, groin, back part of the pelvis, and top of the thigh. The absorption of the blood from the cavity of the vaginal tunic, which was effected at the end of a couple of months, was followed by a radical cure.

Puncture at several points with an acupuncture or large sewing needle has latterly been employed. A small bead of serum forms over each place of puncture with the needle. The fluid of the sac becomes effused into the subcutaneous cellular tissue, and is taken up by the absorbents so as to cause the speedy disap-

pearance of the tumour. A radical cure is, however, but seldom effected by this process, which is now chiefly employed merely as a means of determining in doubtful cases the nature of the swelling.

Radical cure.

By injection.—After the evacuation of the fluid by the puncture with the trocar as above described, various stimulating fluids (by means of a gum elastic bag or a syringe the nozzle of which is well fitted to the canula), are thrown into the sac, and allowed to remain a sufficient length of time to develop some sensation of

heat and pain in the part, as well as some shooting pain in the loins and in the direction of the spermatic cord. This requires, according to the nature of the fluids used, from two to six minutes, at which time they are to be carefully withdrawn again either by forcing them out by pressure through the canula, or by suction with the same instrument that has been used for the injection. Port wine, diluted alcohol, solutions of sulphate of zinc, copper, etc., and Lugol's tincture of iodine, are the materials that have been commonly employed in the injection. Of all these various preparations, that of the tincture of iodine, in the proportion of one part of the tincture to two, three, or four of water, is so in-

PLATE LXII.—HYDROCELE. SARCOCELE.

HYDROCELE OF THE LEFT SCROTAL CAVITY.

- Fig. 1.*—*Puncture of the hydrocele with a trocar.*—The tumour is embraced with the left hand of the surgeon, in such a manner as to render its lower portion prominent. The trocar covered with its canula is introduced with the right hand in a direction obliquely upwards and backwards, so as to avoid the testicle. The fore finger is extended upon the instrument in order to limit the extent to which it penetrates.
- Fig. 2.*—*Excision of a portion of the skin and tunica vaginalis testis.*—This old operation was practised by Dupuytren where, as he thought, the integuments were so abundant as to render it necessary to remove a part. The fluid is to be first evacuated by puncture, and the puncture itself extended upwards by an incision. A portion of the skin and serous sac is then to be removed, as shown in the drawing, with the forceps and scissors.
- Fig. 3.*—*A trocar placed as in the ordinary operation for tapping.*
- a.* Lines of direction of the trocar; the oblique direction in which it is first entered is changed to the perpendicular, as shown by the dotted lines (*b*). As the fluid escapes and the cavity of the scrotum diminishes, the canula as shown at *a*, is raised towards the pubis.
 - c, d.* Pott's method of introducing the seton, shown for convenience on the same figure.
 - c.* A canula, which has been introduced on a trocar in the ordinary manner, though entered more at the bottom of the scrotum.
 - d.* A pointed stilet which is entered through the canula, passes through the skin above and draws after it the seton.
 - e.* Usual position in which the testicle is found.
- Fig. 4.*—*Process of Baudens.*—Puncture with the canula of this surgeon shown at *fig. 8, a, b, c.*
- a.* The canula, pierced with a hole upon its side, represented sheathing the trocar-stilet, the projecting handle of the stilet not being shown.
 - b, c.* The stilet shown separate and in two portions, for the sake of convenience of representation. The trocar and canula are to be introduced into the sac in the ordinary manner, and then made to pierce the walls again at the bottom part of the cavity. The canula is allowed to remain after the evacuation of the fluid, as seen in the drawing. It serves the part of a foreign body to excite adhesive inflammation in the sac, and discharges the fluid as it accumulates by the orifice in its side seen at *fig. 8, a.*
- Fig. 5.*—*Extirpation of the thin reflected portion of the sac in cases of children. (Process of the Author.)*—A puncture is made into the sac with the ordinary thumb lancet. As the fluid escapes it bulges before it a fold of the serous tunic. This is to be seized with the forceps, drawn out as far as it will readily come, snipped half across at its base, and again drawn out and the process repeated till a considerable part of the serous lining is removed.

SARCOCELE.

- Fig. 6.*—*Ligature of the arteries of the cord, proposed as a means of arresting the growth of a commencing sarcocele by causing atrophy of the organ. (Process of Maunoir.)*—One of the spermatic arteries is represented tied—the other is raised on the grooved director, ready to be embraced by the ligature.
- Fig. 7.*—*Castration; or, extirpation of the left testicle for sarcocele.*—A longitudinal division having been made of the coverings of the testicle, an assistant draws off one lip of the wound with the thumb and fore finger of each hand, while the surgeon loosens the attachments between the vaginal tunic and integuments with the knife. The cord is finally to be divided, and the organ detached as described in the text.

Fig. 7.



Fig. 2.

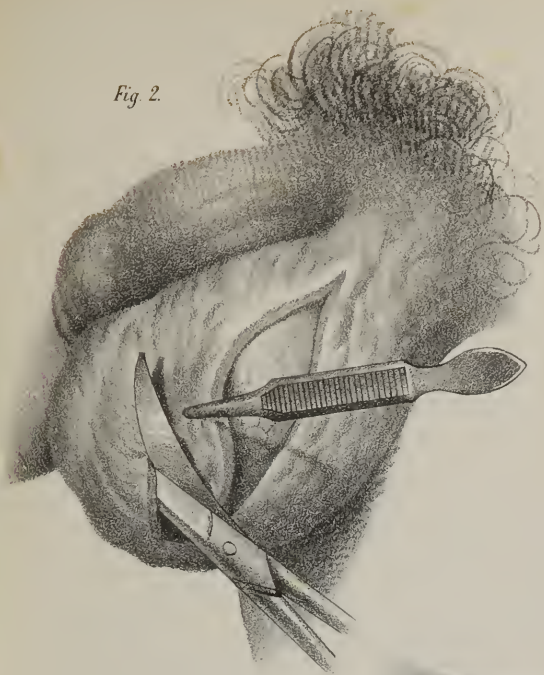


Fig. 1.

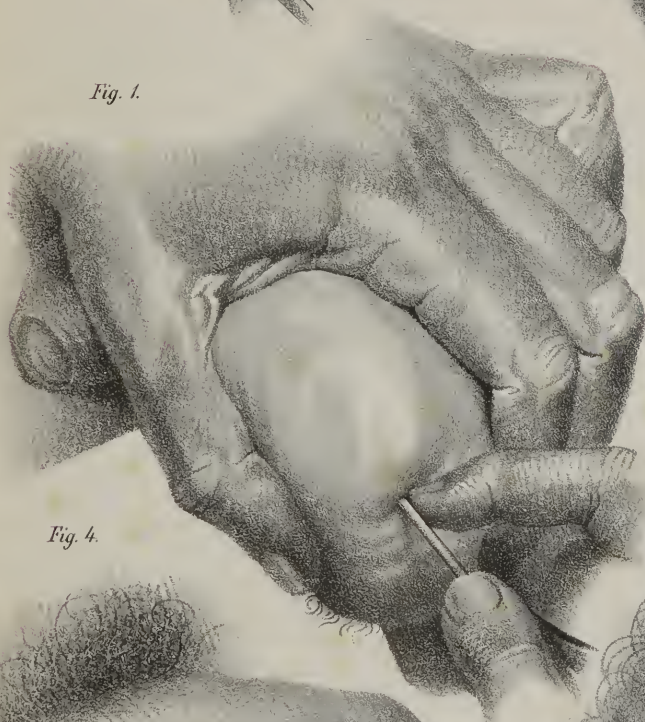


Fig. 4.

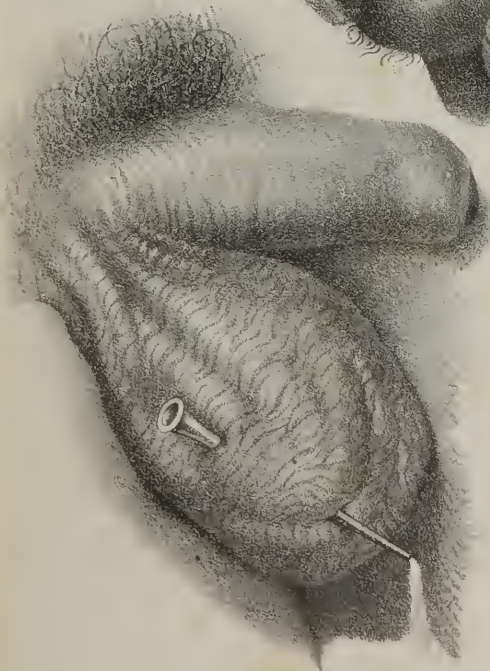


Fig. 6.

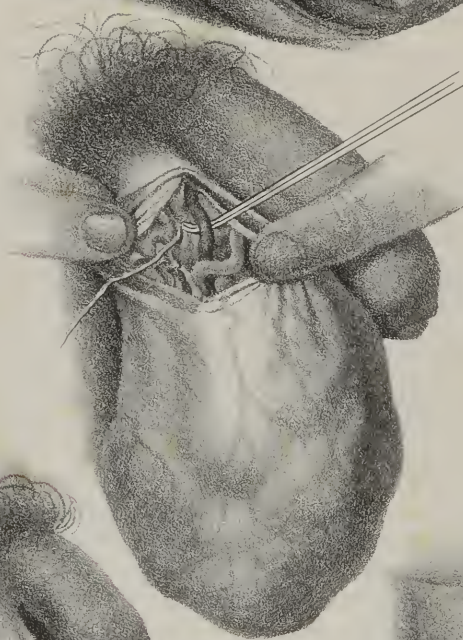


Fig. 5.

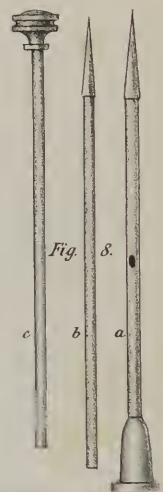
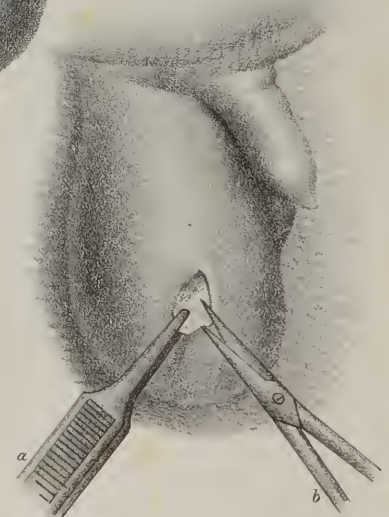
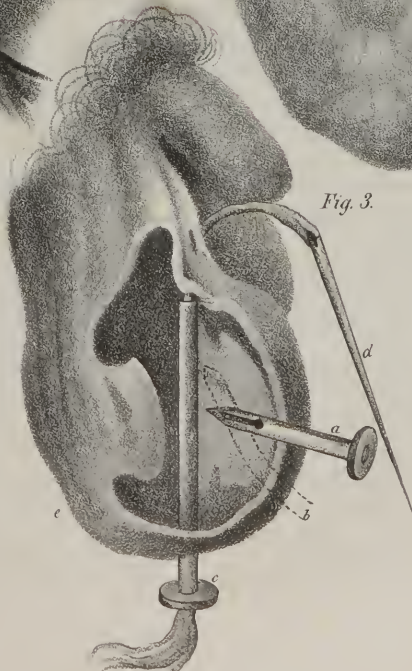


Fig. 3.



comparably superior to all the rest that it has completely supplanted their use. In thirty cases in which the author has employed it, it has proved completely successful, and without producing—except in one single instance where the tumour extended nearly to the knee, and was of many years standing—any results calculated to excite serious apprehensions. The tincture of iodine may be considered the only fluid capable of exciting the requisite degree of inflammation in the vaginal tunic without some risk of suppuration and gangrene. The manner of employing it is as follows. From three to four ounces of diluted tincture, according to the size of tumour, is to be placed at hand. The water is then to be evacuated by puncture, as in the palliative treatment. A caoutchouc bag, with a brass nozzle exactly fitted to the canula lodged in the puncture, is then emptied of air by pressure, and the nozzle introduced into the fluid, which will be sucked up by the elastic expansion of the walls of the bag. The surgeon then presses with the bag till the fluid appears at the mouth of the tube, and ascertaining positively that one end of the canula is still lodged in the cavity of the vaginal tunic, fits the nozzle into the free end of the canula, and forces the fluid by gentle pressure into the sac. If there is reason to fear that the vaginal tunic communicates with the peritoneum, either from a congenital defect, or in consequence of the distension of the fluid which in large hydrocele is sometimes found to dilate the inguinal canal, pressure should be made either with the fingers of an assistant or a truss over the internal ring. After the fluid has remained for a minute in the sac, the bag should be allowed to expand to draw the fluid out, and allow of its being again injected. By distending the sac in this manner two or three times, and pressing with the fingers upon different parts of the scrotum, all the folds of the collapsed serous bag are brought into contact with the fluid. As soon as the patient begins to complain of some heat and shooting pain, the fluid may be finally withdrawn by the bag. The canula is then removed, and the place of puncture covered with a small pledget. The sero-lymphatic effusion which results from the inflammation excited by the iodine, in the course of a day or two enlarges the tumour again to half or two-thirds of its former size. But the serum is speedily removed by absorption, and the lymph remaining unites the surfaces of the vaginal sac and effects a radical cure. If there is so much pain or inflammation excited as to cause suffering, which is but seldom the case, the parts may be leeches and fomented.

The following processes were formerly much employed in the cure of hydrocele, though the greater success which has attended the iodine injections, has caused their nearly total abandonment.

By excision. (Pl. LXII. fig. 2.)—The excision of a piece of the scrotum and vaginal tunic, is a practice noticed by Celsus and Abulcasis. With the exception of Dupuytren, it has been viewed with but little favour by modern surgeons. It is painful and liable to be followed by violent inflammation and sloughing. The mode of its performance will be sufficiently well understood by reference to the drawing.

A modification of this operation has been successfully practised by Kinder Wood, which is entitled to much greater favour. It consists merely in making a puncture through the skin with a broad-shouldered lancet, drawing out the vaginal tunic, and excising a portion of it with a pair of scissors. The author has in four instances operated successfully by a process (Pl. LXII. fig.

5,) nearly similar to this, in the hydrocele of children; but in one of the cases it was found necessary to repeat the operation.

By incision.—This is also an old operation. It was the one very commonly employed, till the introduction by Sir James Earle of the principle of cure by injection. It, however, exposes the patient to pain and protracted suffering, and should only be practised, according to Sir A. Cooper, when the hydrocele is complicated with hernia, or with a suspicious state of the testicle, or, as mentioned by Mr. Curling, in cases (which are of but rare occurrence), where loose cartilages are found in the sac, like those of the bursal membranes. The skin and sac at the upper two-thirds of the tumour are to be laid open with the bistoury. Formerly flour was sprinkled in the cavity of the sac, or a mesh of lint introduced, in order to excite sufficient inflammation to cause the obliteration of the sac by granulation. A simple poultice applied over the wound, as directed by Cooper, will, however, usually be found sufficient.

Some practitioners have combined with the simple incision above described, the partial or complete excision of the loose portion of the tunica vaginalis. The results of this modified operation are rather uncertain. It sometimes answers well—sometimes is followed by violent inflammation, and in other instances fails to effect a cure.

By tents and canulae.—This is an old operation, and was practised by Sabatier, Boyer and Larrey. It consists in making a broad puncture into the tumour, and after evacuating the serum introducing a mesh of lint or a gum elastic canula, for the purpose of producing active inflammation of the serous tunic.

Baudens (Pl. LXII. figs. 4, 8) has modified this process by covering a long needle (fig. 8, c, b) with a canula (a), pierced with a lateral orifice at its middle part. The little trocar is carried through the cavity of the tumour by making two punctures of the skin at the distance of an inch and a half apart. The stilet is then withdrawn, and the canula secured in its position by a thread passed from the two free extremities in the form of the figure 8. The fluid of the tumour enters through the lateral orifice of the canula, and flows from the lower end of the tube as shown in the drawing. In the course of six or eight days the fluid secreted from the vaginal tunic, makes its way round the sides of the canula. The canula may then be withdrawn, and a fistulous orifice will remain which, according to Baudens, will close up spontaneously at the end of eight days more, when the radical cure will be found complete.

By the seton.—This process was brought particularly into notice by Pott. It consisted in tapping the tumour at its lower part with the ordinary canulated trocar. Through the canula of this instrument he next introduced the proper seton canula—a silver tube five inches long, which was pushed up till its point could be felt through the integuments at the upper part of the tumour. Through the seton canula a long-eyed stilet charged with the seton, was passed up and brought out through the integuments, bringing with it the seton. The second canula was then withdrawn and the seton alone left in the wound, where it was retained till it had excited a sufficient degree of inflammation to cause the obliteration of the vaginal pouch. M. Laugier has recently modified the means of passing the seton. He employs the ordinary trocar and canula. He first passes the canula into the sac, then out through an opposite portion of the wall; next he withdraws the stilet or trocar,

passes the seton by means of an eyed probe through the canula, and finally removes the canula, leaving the seton in place.

The employment of the seton is occasionally followed by a protracted, offensive suppurating discharge. It is, however, after injection, the process most commonly employed. In cases of children, when external stimulating applications failed to effect the absorption of the fluid, Sir A. Cooper introduced the seton with a common curved needle transversely across the tumour.

Hydrocele of the Spermatic Cord.

In this variety of hydrocele the tumour is of a more cylindrical shape than in the more common form just described; from the latter it may, however, readily be distinguished, as it is developed downwards towards the scrotum, and never, however great is the enlargement, draws the integument over the penis to the same extent. It might without care be mistaken for irreducible omental hernia, though the swelling is generally smoother and fluctuating, especially at its lower part. The diagnosis must be clearly made out in this affection before any operation can be warranted. The introduction of a seton, and the incision of the sac, are the processes generally resorted to for the cure. The author, however, has succeeded more satisfactorily in these cases by the use of the iodine injection—on one of which he has operated during the past winter at the Philadelphia Hospital. Great care, however, is required in introducing the injection, to keep the canula from getting displaced from the sac, and in using but little force, for fear of rupturing the walls of the serous cyst, and filling the surrounding cellular tissue. For fear of this result, no other fluid but the diluted iodine can be deemed appropriate, as this would be but little likely to produce serious inconvenience, even though it were left in the cellular structure.

Encysted Hydrocele.

This form of the disease, in which the fluid is collected in cysts or vesicles, may be developed in the substance of the epididymis, between the tunica albuginea testis and its serous layer, or in the cellular structure of the spermatic cord. In the latter position we sometimes encounter a string or chaplet of separate cysts. These tumours, when so large as to produce inconvenience, are to be treated by simple puncture merely, by the seton, incision, or iodine injections.

Hydrocele in the Child.—Congenital Hydrocele.

Congenital hydrocele consists in the accumulation of serum in the vaginal tunic, before the peritoneal orifice of this passage has been closed at the internal ring. It is distinguished by the facility with which the fluid may be forced by pressure into the cavity of the abdomen. It may show itself at any period between birth and the sixth or eighth year. The pressure of the fluid into the abdomen, and the nice adjustment of a common hernial truss, usually suffice for its cure. If it should not, the palliative cure by puncture might be tried, or the process of Kinder Wood as modified by the author. Desault and Velpeau have effected a cure in some instances by the process of injection, using the precaution to make pressure at the ring, in order to avoid the escape of the fluid into the cavity of the abdomen. In a young child this process fortu-

nately is seldom needed, and would be attended with more or less danger.

In many instances of hydrocele in children the peritoneal passage will be found closed, and the tumour, corresponding in appearance with that of the adult, requires the same method of treatment. The milder processes, however, that simply by puncture with the lancet, trocar, or acupuncture needle, and that by iodine injection, are chiefly relied on where the tumour cannot be dispersed, as it frequently may be, by local applications.

In four instances the author has employed with advantage the following process, which he has since discovered to be analogous in many respects to that of Kinder Wood.

*Process of the Author.**—The swelling is to be punctured in front and below its middle with a broad thumb or abscess lancet. As the serum flows, a little pressure causes the thin serous tunic to protrude through the puncture in the form of a cyst. This is to be laid hold of with the forceps, and drawn out as far as it will yield. The lower half of the cyst next the skin is then to be divided with a pair of scissors; traction being again made upon the cyst, still more of its wall is to be drawn out and snipped in like manner as before with the scissors. By repeating this process, a large part of the loose vaginal tunic may be removed. The operation is attended with scarcely any pain, and the child may be allowed to run about as usual.

Hydrocele in the female.—It may be well to observe here, that hydrocele is occasionally found in the female, either in the course of the round ligament or in the cellular substance of the labia majora. A case of the latter description I have had recently under charge at the Philadelphia Hospital. The evacuation of the fluid contents by puncture is usually attended with only temporary benefit. The injection with the diluted tincture of iodine, is the process principally to be relied on for the cure.

SARCOCELE.

This vague term is applied to any chronic degeneration of the testicle, whether tuberculous, syphilitic, or encephaloid—affections which are very different in their nature. The operations which have been employed in these cases, *when all medical measures have proved unavailing*, consist of ligature of the vessels of the testicle, and castration; the latter being the only one that can with any confidence be relied on in unequivocal cancer. Though the nature of this work does not allow the author to enter into the particular study of these affections, it may be well to observe that the researches of modern pathologists have greatly narrowed the proportion of cases in which so serious an operation would be justifiable.

Ligature of the spermatic vessels. (*Process of Maunoir*, Pl. LXII. fig. 6.)—An incision an inch and a half long is to be made so as to expose the cord just below the external abdominal ring; the spermatic and other arterial branches of the cord are to be isolated by a careful dissection. Each artery is to be tied with two ligatures, and divided across. Maunoir also recommends the complete section of the cord after the ligature of the vessels, leaving the testicle in place, which subsequently becomes atrophied. This process, which appears to have been successful in some in-

* Vide American Med. Library and Intelligencer, June, 1842.

stances, has not yet been sufficiently tested to entitle it to much consideration.

Process of Morgan.—This consists merely in the excision of a portion of the vas deferens an inch or two long, and closing the wound by first intention, without disturbing the other vessels.

Castration.

This operation may be divided into three periods—the division of the coverings, the dissection of the testicle, the division of the spermatic cord and the ligation of the vessels. The patient should be placed semi-recumbent on a table or a bed, with his legs separated and supported on a couple of stools. The hair should be shaved from the parts, and the rectum and bladder emptied prior to the operation. In cases of doubt as to the state of the testicle in hydro-sarcocele, a small exploratory incision may be made with the bistoury, to evacuate the fluid and determine the character of the glandular affection.

Incision of the integuments.—The operator takes the scrotum in the palm of his left hand, and with the thumb and fingers stretches tense the coverings in front of the gland. These are now divided, with one stroke of the knife, from the external abdominal ring to the bottom of the scrotum. An incision to this extent is required partly for the convenient removal of all the diseased parts, and partly for the purpose of leaving no sac at the bottom of the pouch as a receptacle for pus. If any portion of the skin is diseased or even adherent in front of the gland, it is to be embraced by two elliptical incisions. Some of the branches of the external pudic arteries which are found enlarged, may require to be tied.

Dissection of the testicle.—An assistant now grasps the skin of the scrotum, as shown in the drawing, and if possible everts or enucleates the testicle with its investing vaginal tunic. If the tumour is small, the attachments of the gland will be slight, and found at the posterior and inferior part of the scrotum. If the adhesion is more extensive, the surgeon draws the tumour to one side with his left hand, and detaches it upon the other with the knife, taking care to avoid cutting the urethra, the septum scroti, or the gland of the other side. An assistant next draws the testicle in the opposite direction, and the surgeon, pressing down the margin of skin, loosens the remaining attachments with the knife.

Division of the cord.—An assistant is now to sustain the weight of the tumour and prevent its dragging on the cord, while the surgeon raises and divides the cremaster muscle on the front of the cord, and isolates the latter by passing his finger below it. Having ascertained that the disease has not extended beyond the point at which the cord is exposed, the surgeon either ties it firmly at once in a mass with a strong ligature and completes the operation by dividing it below the ligature and detaching the tumour;—or adopts the practice of Desault, and divides it obliquely over the finger little by little with the knife, pausing to take up separately each one of the arterial branches as they bleed; for if the cord were divided at a single stroke, it would be disposed to retract (and more especially if not well loosened from the cremaster) into the inguinal canal, so as to render it difficult to check the hemorrhage from the divided vessels. The ligation of the cord in mass is more certain to prevent bleeding, and though it has been objected to as more painful and more liable to be followed by tetanus,

the author, after repeated trials of both processes, is disposed with Velpeau and Malgaigne to accord to it the preference.

Many surgeons prefer to divide the cord previous to the isolation of the gland, as a means of diminishing the pain attendant on the operation. This is a practice that may be adopted at the will of the surgeon, when he is certain that the disease does not extend along the vas deferens or other constituents of the cord above the external ring. But when it becomes necessary, either by drawing it down or slitting up the tendon of the external oblique, to divide the cord above this point, or it is desirable to remove some of the glands in the vicinity of the root of the penis, the author has found it most advantageous to retain the testicle in connection with the cord.

Dressing.—The ligatures of the cord are to be brought out at the upper angle of the wound. The divided arteries of the scrotum should be tied and the threads brought out at the nearest point. A strip of oiled linen may be interposed between the lips at the inferior end of the incision, and the wound closed with a couple of sutures and one or two adhesive straps, supported with a compress and a T bandage. The patient is to be placed in bed, with his thighs and thorax in a flexed position. The sutures should be removed on the sixth or seventh day. The wound usually closes in the course of three or four weeks. In case a hernial tumour should unexpectedly be discovered behind the testicle, as in one or two instances has been the case, considerable embarrassment might arise, as the hernial contents, if not injured in the operation, would be liable to protrude after the division of the cord. When, therefore, the cord appears unusually large and tumid, the surgeon should examine it with particular attention previous to dividing it with the knife. A few cases are on record in which it has been found necessary to remove a testicle which had remained above the external ring—the principal peculiarity of the operation being that of beginning the operation higher up, and extending the incision through the tendon of the external oblique muscle.

VARICOCELE AND CIRSOCELE.

Varicocele consists in a varicose enlargement of the veins of the scrotum. Cirsocele is an analogous enlargement of the proper venous plexus of the cord, known under the name of *corpus pampiniforme*. Though these affections are occasionally the source of much physical and moral suffering, they neither of them involve the risk of life. In a majority of cases the symptoms to which they give rise may to a great extent be palliated by the habitual use of a well-fitted inelastic suspensory truss, and it is only in instances where this simple contrivance fails to afford relief, that the attempt to effect a radical cure by bolder measures can be deemed justifiable, since the various processes by which the radical cure is achieved are, as experience shows, occasionally attended with more or less risk of phlebitis and atrophy of the gland. These several processes may be arranged under four principal heads—1, division or excision of the veins; 2, ligation; 3, compression; 4, shortening of the scrotum.

1. *By division or excision.*—This is an old process. Celsus cut down upon the veins, and, according to circumstances, either tied or extirpated the whole cluster of varicose vessels. This practice,

in which he was followed by most of the older surgeons, has been rejected by the modern. Sir Benj. Brodie, however, advises the division of the varicose vessels with the knife. He exposes them by an excision at the posterior part of the scrotum, and simply cuts them across with a sharp-pointed bistoury. The hemorrhage which follows is readily checked by cold applications, and the wound is left open to allow the blood to escape. Some inflammation and swelling, but no serious symptoms, according to this surgeon, follow the operation.

2. *By ligature.*—The old practice of cutting down upon the vessels for the purpose of tying them has long been abandoned, in consequence of its liability to be followed by phlebitis, which under such circumstances has been the cause of death. Various ingenious processes have latterly been devised for applying the ligature so as to diminish this risk. Most of those, indeed, resorted to for varicose veins of the leg, have been tried upon the veins of the cord.

Process of Davat.—This surgeon first proposed to pass a needle or pin under the veins, (between them and the vas deferens)—strangulating them by surrounding the pin with a thread, as described in the operation for varicose veins of the leg. The vas deferens, in consequence of its wiry hardness, can usually be readily distinguished from the veins, and should be carefully separated. Where it cannot be so distinguished, the operation by subcutaneous ligature of the veins should be altogether abandoned, as the enclosure of the vas deferens in the loop would almost certainly involve the loss of the testicle, by atrophy or suppuration. The process of Davat, however, is not found so well suited to the veins of the scrotum as to those of the leg.

Process of Reynaud.—This surgeon separates the spermatic nerves and vessels from the vas deferens with the thumb and fingers of the left hand, and between them passes a waxed thread with a needle, through the two sides of the fold of skin. When the fold is relaxed, the places of puncture should appear about an inch apart. The two ends of the thread are then tied in a bow knot over a short but thick cylinder of linen, so that the compression may be subsequently increased or relaxed at the will of the surgeon. A simple compress laid over the apparatus is all the dressing required. If much pain or inflammation immediately follow, the thread may be slightly loosened. This, however, is seldom requisite. The thread is to be successively tightened at intervals of two or three days. In the course of fifteen or twenty days the vessels and nerves of the cord are usually found divided. The thread is then to be withdrawn, and the portion of skin included between the punctures severed with the knife. M. Vidal has modified this process by substituting in place of the thread a silver wire, which he merely twists over the cylinder.

Process of Ricord. Subcutaneous operation.—The loop of a double ligature is carried with a lance-pointed needle between the veins and the vas deferens, as in the process just described. A needle charged with another double ligature is then entered from the puncture last made, and brought out at the first place of puncture of the skin, but passing so as to lodge the second ligature between the veins of the cord and the skin. The loose ends of each ligature are then passed through the corresponding loop of the other, which is lodged in the same place of puncture. The ends are then drawn in opposite directions; the loops slide in

through the cutaneous punctures, and all the constituents of the cord, with the exception of the vas deferens, are constricted between them. The constriction is kept up and gradually increased from time to time by a sort of tourniquet shaped like a horse-shoe, over the ends of which the threads are brought up to avoid the strangulation of the skin intermediate to the places of puncture. At the end of from ten to twenty days the ligatures are found to move freely from side to side, and may be withdrawn.

Modification of this subcutaneous process by the Author.—In four instances I have employed with success the following process, described in the Philadelphia Medical Examiner for March 4, 1843. "Previous to the operation, the patient is to be directed to walk about for an hour or two with the scrotum unsupported, so as to cause an accumulation of blood in the enlarged veins. He is to be seated on the side of his bed, with the legs separated. The thumb and fore finger of the left hand are then to be pressed in, so as to lift up the enlarged veins, and thus separate them from the vas deferens. This duct is readily distinguished by its hard and wiry feel, and is to be pressed off with the nail of the left fore finger towards the os pubis. A long, round, lancet-pointed needle, curved near the point like that of the sail-makers, and threaded with a piece of fine but strong hempen twine passed double through the eye, is then carried between the bundle of veins and the vas deferens; entering it on the side of the thumb, and bringing out the point against the pulpy portion of the finger. The loop of the double ligature is to be detached from the needle; the ligature being left in the track of the wound. The needle, without being threaded, is again to be entered through the same orifice of the skin as before, but carried this time between the skin of the scrotum and the veins of the cord, and its point brought out through the other puncture made in the skin on the side next the pubis. To facilitate this step, the skin should be lightly raised up from above the veins with the thumb and finger. If there be any enlargement of the subcutaneous veins of the front part of the scrotum, as there was in one of my cases, I carry the point of the needle so as to scrape the under surface of the skin, and get it in front of these veins. The needle is now to be left in the wound. I manage to have the place of entry of the needle lower than its place of exit; so that the point of the instrument, which should be pushed well through, may lie undisturbed, without pressing over the root of the penis. The course of the instrument across the cord will be, therefore, rather diagonal than transverse. The loop of the ligature (which lies next the pubis) is now to be thrown over the point of the needle. Traction is next to be made upon the other side, upon the loose ends of the ligature, so as to draw the loop along the needle, through the orifice in the skin. One tail of the ligature is now to be drawn out for four inches, so as to shift the portion of the thread forming the loop over the needle, for fear that this might have been cut by the point or edge of the needle, so as to break when subsequently knotted. The loose ends of the ligature are then to be tied with a single knot over the shank of the needle; this is to be drawn as tightly as possible, so as to completely strangulate the veins of the cord, which will be thus enclosed by the double ligature on its back part, and the needle in front. To make the strangulation more effectual, the two ends of the loop thus formed over the needle may be slid towards each other, by pressure through the skin,

and the knot again tightened. This step is followed by severe pain, which gradually diminishes, and at the end of half an hour ceases almost entirely. To be able to tighten the ligature again at the end of two or three days, when it will be found loosened by having partially cut through the compressed mass of veins, I slide an oblong piece of sole leather pierced in the centre and notched at the ends, over the heel of the needle, and make a firm double bow knot of the ligature above it. The point of the needle is to be sheathed in a small cork, and a compress placed below it to prevent its worrying the skin. A piece of thick tape is to be passed through the eye of the needle and knotted, in order to prevent the needle, when it becomes loosened by suppuration, from being pressed through the hole in the leather by the movements of the thigh, so as to detach the loop. The scrotum is to be slightly supported by a couple of silk handkerchiefs, folded, and placed below it. No dressing is required. If neuralgic pains arise, they are to be soothed by hot fomentations, and the administration of anodynes. I untie the ligature over the leather every third day for three successive periods, tightening it again as much as possible at each time. On the eleventh I remove the needle; the loop, which is then left detached, and will be found but small from the successive tightenings, is at the same time withdrawn. Above the place of the ligature, the condition of the cord will be found perfectly natural; below it will be found a hardened mass of the size of a walnut, formed by the effusion of lymph, between, and in all probability in the cavities of the veins, causing their complete obliteration. The pain attending this process of cure is but trifling, except at the periods when the loop is tightened. There is no injury done to the integument, such as to leave an obvious scar after the cure is completed, for the needle, if introduced in the manner I have mentioned, lies so completely at rest, as to cut but very slightly at the places of puncture; and as it makes no pressure in the downward direction, cannot by any possibility impair the integrity of the vas deferens. After the withdrawal of the needle, a light poultice may be laid for a few days over the part, to promote suppuration from the points of puncture, and to facilitate the resolution of the tumour left—a result which is quickly effected.

“The advantages of this method of operation will, I think, be found sufficient to recommend it to the notice of practitioners. The plan of cure recommended by Sir A. Cooper, which involves the excision of a part of the scrotum, is severe, dangerous, and frequently inefficacious. The methods of Brcschet and Ricord are complicated by the use of a cumbersome apparatus. That of Reynaud is attended with a division of the integuments, which leaves, like the three former, a permanent cicatrix, and the modification of this, as suggested by M. Vidal, appears by no means free from objections.

“By the modification which I have proposed, it is possible at any moment, in case the strangulation of the veins and nerves of the cord should give rise to obstinate neuralgic pains or retention of urine, to relieve the patient by slackening temporarily the ligature, and to shorten the period of treatment by removing the ligature, when the effusion of lymph has completely obliterated the diseased veins, without waiting for it to cut entirely through the enclosed parts. But should it be deemed necessary in certain extreme cases to have this division effected, thereby to present

an additional obstacle to the return of the disease, as when the effusion of lymph does not seem sufficiently abundant, we can accomplish the result the more readily by this method, which gives us the power to tighten the loop from time to time, in proportion as it becomes loosened.

“By keeping the cavity of the veins in the grasp of the ligature thus *constantly* closed, the risk of purulent absorption from the veins below is greatly diminished, if not entirely removed; for the constituents of the cord above the site of the operation are scarcely at all affected. The details of the operation are given for the left side, for it is upon that, almost exclusively, that the disease is found to exist, in consequence, it is most probable, of the entry of the left spermatic veins into the emulgent at a right angle to the course of the latter; while those of the right open into the vena cava nearly parallel with the direction of that vessel.”

3. *By compression.* (Pl. LXIII. fig. 5.)—This has been thought by some a safer means of obliterating the veins than either of the foregoing, inasmuch as the risk of phlebitis is diminished, by the instruments employed not being brought in immediate contact with the coats of the veins. The following method was devised by M. Breschet for this object. A pair of forceps, well padded, the construction of which is shown in the drawing, is to be tightened with a screw over an elevated fold of skin which includes the enlarged veins, so as to force the sides of the vessels together, and cause the obliteration of their cavities by the coagulation of their contents, and the inflammation which the pressure develops. Before the application of the instrument, the patient should take a warm bath, or walk about with the scrotum unsupported, to allow the veins to become distended, as they will in this state be better retained within the grasp of the forceps. Two of these instruments will usually be required. They should be applied transversely over the scrotum, but so as not to include the septum scroti nor the vas deferens, which should be carefully held out of the way by an assistant. The instrument is to rest over the scrotum upon a pad of lint or a light compress, and be supported by some adhesive straps attached to the abdomen. This operation, though protracted, causes little pain. The compression is to be gradually increased from time to time, till it transforms the parts embraced into a dry, thin, parchment-like eschar. The ulcer which follows the detachment of the slough usually cicatrizes in a short time.

A new and singular method of effecting a cure by compression has recently been proposed, but which has not as yet been sufficiently tested to entitle it to much consideration. It consists in wearing a truss, so constructed as to exert a constant pressure upon the spermatic vessels just below the abdominal ring. It is said that the varicose veins, which enlarge by a slight pressure against the abdominal ring—a circumstance that enables us to distinguish varicocele from hernia—become *actually diminished in size under firm and constant pressure*. If this effect should be owing to the obstruction of the spermatic arteries by the pressure, it would be a question whether it would not be safer and attended with less risk to the spermatic duct, to cut down upon and tie the spermatic arteries, as practised in these cases by Maunoir and Amussat.

4. *Shortening of the scrotum.*—The only object of this process

is to diminish the dimensions of the scrotum, as to make it serve the part of a suspensory bandage. The following operation was devised for this purpose by Sir A. Cooper, but it has been and probably will be followed but little by any other surgeon, since nearly as good palliative results may be attained through the use of the ordinary bag truss. It consists in drawing out the relaxed part of the scrotum with the left hand, and removing it with the knife or scissors; the testicle being protected from injury by an assistant who draws it up towards the external abdominal ring. The bleeding vessels are next secured, and the wound closed by sutures. A suspensory truss is then applied, and the patient confined to his bed for a week or ten days.

Dr. J. Watson* has recommended that the piece removed, instead of being transverse, should correspond in its long diameter with the direction of the cord.

Process of Lehman.—This consists in invaginating a portion of the scrotum on the finger, and fastening it by sutures at the abdominal ring, as in Gerdy's operation for the radical cure of hernia. It is, however, but little to be relied on.

Process of Wormald.—This process is at least ingenious and simple, and is said to have been attended with benefit. It consists in drawing the lower and loose part of the scrotum through a ring of soft silver wire, an inch in diameter, well padded, and covered with wash leather. The sides of the ring are then pressed together, so as to prevent the included portion from escaping, and thus give permanent support to the dilated mass of veins. The ring should be constantly worn during the day, and laid aside at night.

OPERATIONS UPON THE PENIS.

These comprise operations for Phimosis, Paraphimosis, Cancer, Hypospadias, and Epispadias.

FOR PHIMOSIS.

This affection may be either congenital, or acquired as the result of gonorrhœal inflammation or preputial chancres. In the former

* Amer. Journ. Med. Sciences, Oct., 1845.

case it is termed *natural*, in the latter *preternatural* phimosis. The latter, whilst in its recent or forming state, I have sometimes been able to retrieve by keeping the surface of the part for some time imbued with an ointment composed of equal parts of extract of belladonna and mercurial ointment, with the addition of a little camphor. The operations for the relief of this affection consist of incision, excision, and circumcision.

Of incision.—This is but a simple operation. A grooved director is to be passed between the prepuce and the glans, up to the collum of the penis. Along this the surgeon glides a straight sharp-pointed bistoury, pierces the upper part of the prepuce, and divides it from within outwards to its free border. An assistant, previous to the incision, should draw the skin of the penis backwards, so as to prevent the division of the integuments to an unnecessary extent. The mucous membrane is found divided to a less extent than the skin, and requires to be opened further with the scissors. A large open wound results, which may be diminished by stitching together the edges of the skin and mucous membrane. By the ordinary process, the section is made over the upper surface of the glans. This, however, leaves two flapping dog's-ear-like appendages, which will in many cases require to be subsequently excised. As a means of rendering the deformity less obvious, J. Cloquet directs the incision to be made on the under surface of the glans by the side of the frenum. In introducing the director for this object, care must be observed that it does not pass into the urethral orifice, the wall of which has, in some instances, been split with the bistoury in the operation. When the margin only of the mucous membrane is thickened, the process of Cullerier and Coster, which consists merely in introducing a probe-pointed bistoury, so as to nick the margin at several points at equal distances from each other, and thus unbridle the orifice, may be found to answer.

By excision. Process of Lisfranc.—This consists in the removal of a semilunar portion of the prepuce from over the dorsum of the glans, with a pair of strong sharp scissors curved on the flat. The top of the piece removed should correspond with the middle portion of the glans.

PLATE LXIII.—OPERATIONS UPON THE PENIS AND SCROTUM.

Fig. 1.—*Appearance of the penis in a case of hypospadias*, in which the urethra opened by a longitudinal slit immediately in front of the scrotum. No urethral canal existed in front of this abnormal orifice. The penis was held bent downwards by the contracted skin of the scrotum.

Fig. 2.—*Operation for the cure of the deformity shown in fig. 1.*—A transverse incision is made in front of the skin of the scrotum, for the purpose of dividing the contracted tissues, and allowing of the straightening of the penis. A trocar and canula has been passed from the fistulous orifice under the skin to the apex of the glans in order to form a new urethral passage.

Fig. 3.—In this figure the steps subsequent to the operation in fig. 2, are shown. The edges of the fistulous orifice have been made raw and closed as well as the transverse wound with two points of the hare-lip suture, over a sound, left in the passage to preserve it patulous.

Fig. 4.—*Amputation of the penis for cancer.*

Fig. 5.—*Operation for varicocele. (Process of Breschet.)*

(A). The peculiar forceps devised by this surgeon for the cure of varicocele. They are shown applied at two different points of the scrotum, so as to embrace the skin and the bundle of varicose vessels raised with it. A compress is interposed between the skin and the instrument, the blades of which are tightened by a couple of screws.

Fig 6

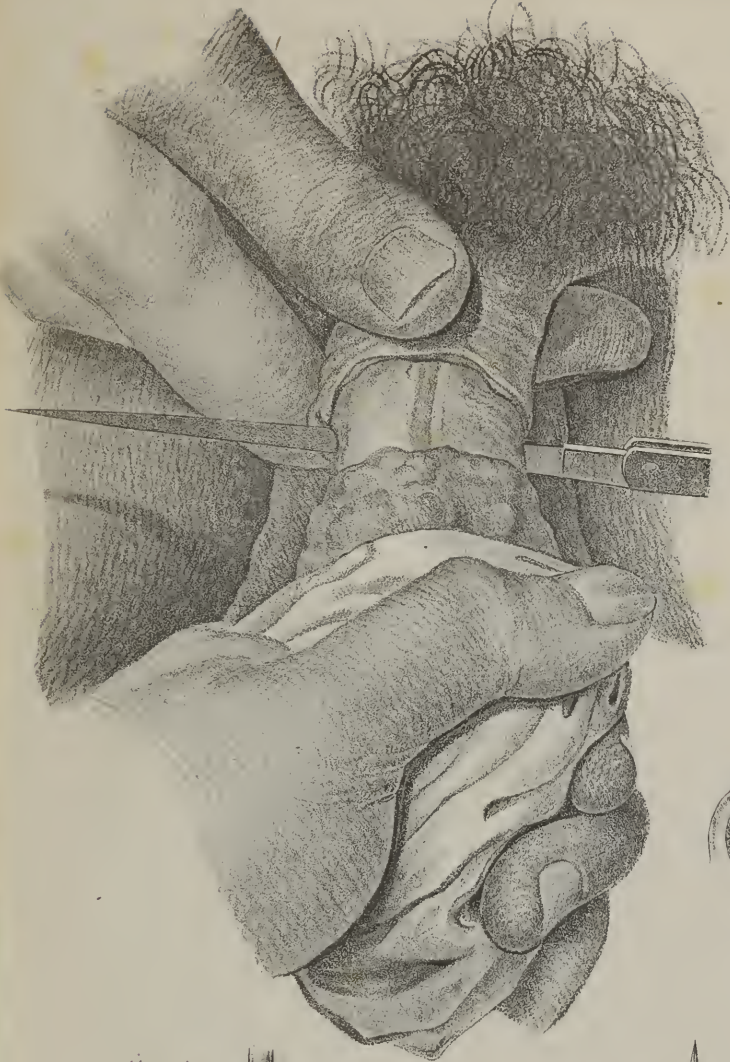


Fig 5

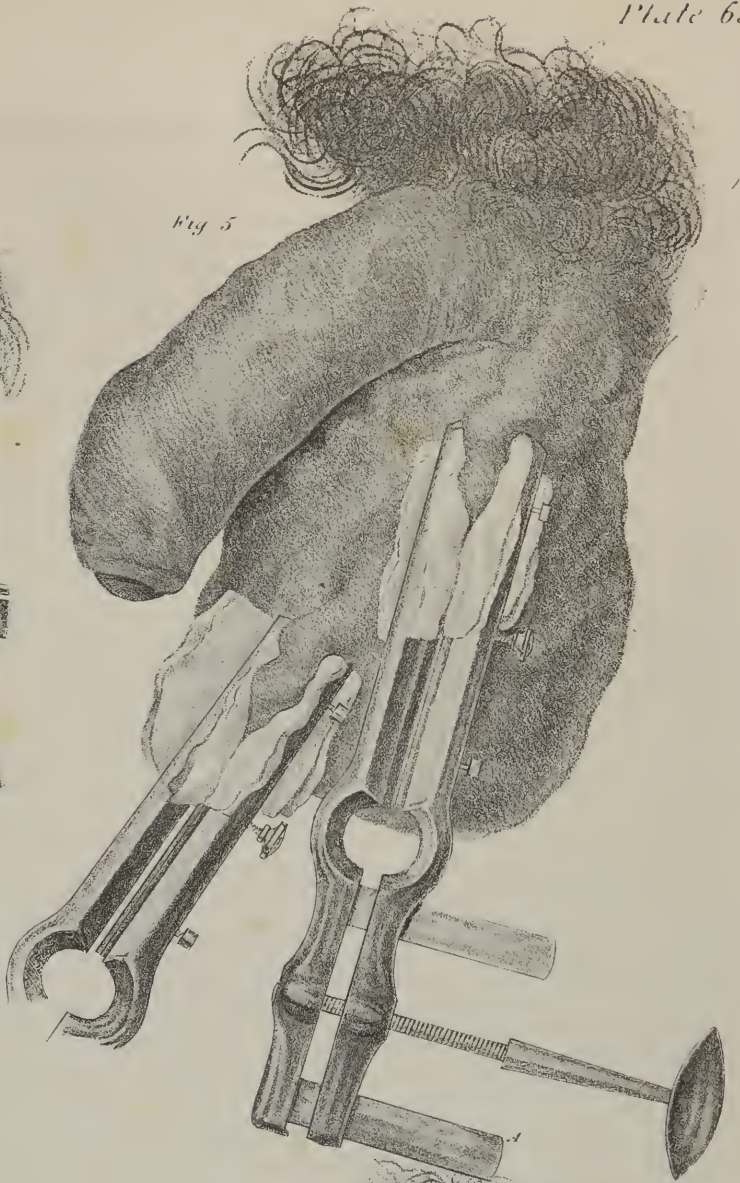


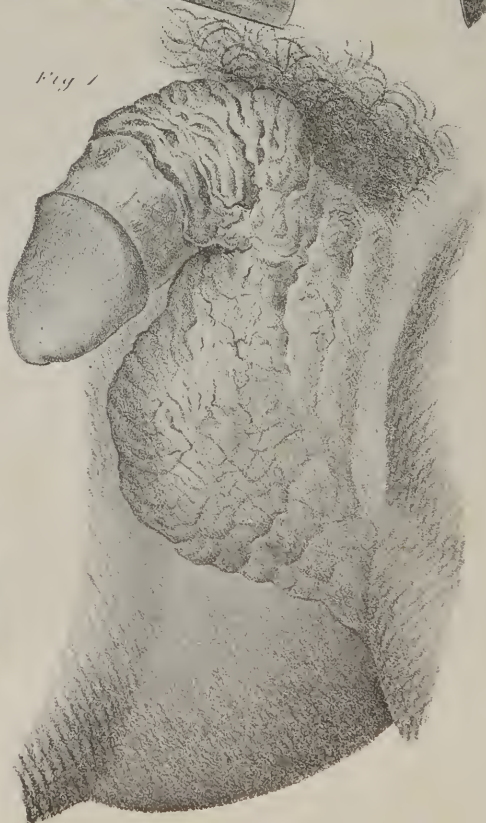
Fig 3



Fig 2



Fig 1



Process of the Author.—Having in the operation for phimosis usually found the mucous membrane thickened, rigid, and shortened, so as to be deprived of its natural degree of elasticity, I have within a few years past been in the habit of performing the following operation, which has furnished results infinitely superior to any with which I am acquainted. Three of these operations were performed before the class of the Philadelphia Hospital during the winter of 1844–5. The patient is to be seated upon a chair or on the end of a table, with his legs separated and supported by a couple of stools. An assistant supports the organ and draws back the prepuce, so as to distend its narrowed orifice as much as possible against the end of the glans. With a pair of straight, sharp, strong, but blunt-pointed scissors, one blade of which is passed between the glans and the prepuce, I excise a Λ shaped piece at two cuts over the dorsum of the organ. The base of the piece corresponds with the orifice, and should be left as broad as the orifice will admit; the apex should reach to the middle of the glans, and the incision extend through the skin and mucous membrane. On the removal of the piece, the assistant draws the skin back as far as possible; to this no resistance is now offered, unless there should be some adhesions between the glans and prepuce that require division. The rigid mucous membrane will be left covering the base of the glans; it is to be opened from the top of the Λ incision up to the corona, and each segment of it raised separately with the forceps, and clipped away at a single running stroke with a pair of curved scissors *completely down to the side of the frenum*, leaving of it nothing but a narrow rim a line in breadth at the point at which it is reflected over the glans. The flaky secretion usually observed in these cases over the glans, is to be washed away. The assistant still retains the divided skin of the prepuce inverted over the body of the organ, while the surgeon introduces with a delicate needle three slender silk ligatures on either side of the glans, each one passing through the rim of mucous membrane left and the margin of the divided skin. The complete success of the operation depends on the nice adjustment of the sutures. The object of them is to invert the skin and make it serve the place of the thickened mucous membrane which has been removed, and at the same time draw the divided edges of the dorsal portion of the prepuce, which is loose and movable, downwards towards the glans, so as to give to the orifice at once its natural rounded appearance. This is effected by introducing the two lower sutures through the mucous rim close to the frenum, and carrying the threads obliquely upwards, passing them next through the edge of the skin at the distance of a quarter or three-eighths of an inch from the frenum. The two middle threads are to be attached on either side to the mucous rim at the junction of the lower with the upper two-thirds of the gland, and to the skin at the same degree of obliquity with the first. The two upper threads pass from the mucous rim at the junction of the upper third with the lower two-thirds of the gland, to the skin, about a quarter of an inch on either side of the middle line on the dorsum of the penis. The two lower threads are to be tied first, and the others in succession, and all the ends cut off close to the knot. The cut margins of the skin and mucous membrane are now brought in apposition. The surgeon rolls the prepuce with his thumb and finger over the glans, and the operation is completed. In case the rules just given are closely followed, no raw surface will be pre-

sented, and the orifice—which will be from half to five-eighths of an inch in diameter—will appear at once almost perfectly natural. No dressing will be required except keeping the parts wetted with a cold lotion, as a measure of precaution against erections. Union takes place by first intention, and will in four or five days be found complete. The prepuce may then be inverted, and the ligatures, if not already detached, cut and withdrawn; previous to this period the parts should not be disturbed. If the lower thread be not adjusted as above directed, a pouch of skin may be formed by the side of the frenum which will be distended by an albuminous effusion. In one of the instances in which I performed the operation during the past winter, such a result followed. It is, however, a circumstance of little moment, as the tumour to which it gives rise is in a little time removed by the absorbents. In cases where the orifice of the phimosis is too narrow to give a base to the Λ shaped piece, it should be dilated by a slight incision on either side. I have, however, under such circumstances, succeeded nearly as well by simply making a vertical incision over the dorsum; though it then becomes necessary in excising the mucous membrane to clip away with it the entire fold which it forms with the skin by the side of the frenum.

This operation of the author will be found suited to almost any form of natural phimosis, and is certainly the one attended with the least amount of suffering, and the most speedy cure. In preternatural phimosis, where the margin of the prepuce forms a hardened ring, the following process will be found the most appropriate.

Circumcision. Process of Ricord.—This consists in the amputation of the prepuce, by a slight modification of the rite as practised by the Jews. Ricord directs the prepuce to be drawn forwards, and the line of incision to be traced with ink or nitrate of silver. Then relaxing the hold of the prepuce, the surgeon is to notice whether the line for the incision falls too far behind the corona. Having determined the proper line, the prepuce is again drawn in front, and grasped between the blades or handles of a pair of long forceps, which should rest against and be parallel with the face of the glans. The part in front of the instrument is to be shaved off at one stroke with the bistoury. The skin is then to be retracted, and the mucous membrane slit up to the corona and excised with the scissors at its line of attachment to the glans, as in the process just described, except that it is necessary in this operation to clip away also the fold of the frenum. No sutures are directed by Ricord, but the cure will be considerably accelerated by attaching the skin to the margin of the mucous membrane by five or six stitches. The parts are to be kept wetted with a cold lotion, and the patient should be put under the occasional use of camphor and opium, to prevent the occurrence of erections.

In dissecting the parts in these cases, I have commonly found the mucous membrane so thick and unyielding, as to feel when grasped between the thumb and finger like a fibrous cord, and so inextensible that all the elongation of the prepuce by traction in front of the glans, is made by the inversion of the proper skin of the penis. In consequence of this, if the operator simply grasps the end of the prepuce within the thumb and finger, draws it in front, and then applies the forceps and amputates the part before the instrument, he will in some cases find that he has merely skinned the penis behind the glans. To obviate this risk, I consider

it better, though somewhat more painful, to draw the prepuce forwards by a couple of small hooks inserted into the skin near its junction with the mucous membrane.

PARAPHIMOSIS.

This is a more troublesome and more serious affection than the preceding, and consists commonly in the strangulation of the glans, when in cases of phimosis the narrow orifice of the prepuce has been retracted and become fixed behind the corona. If relief be not speedily afforded, there will in many cases be imminent risk of mortification of the glans. In recent cases the glans may be readily reduced by first pressing it steadily and firmly for some time between the thumb and fingers of one hand, so as to diminish its size by emptying its swollen vessels, and then grasping the organ with the other hand behind the place of constriction so as to make pressure in opposite directions. If this process does not prove successful, the integument of the penis may be embraced behind the place of strangulation between the index and middle finger of each hand, and drawn forwards while the two thumbs make pressure backwards upon the glans. In case of failure by this means, a stream of cold water may for some time be poured upon the part, some punctures made in the prepuce to diminish the œdematous swelling, and the processes again repeated. The use of the belladonna ointment, referred to under the head of phimosis, is said to have been attended with advantage in this affection. In some instances it may become necessary to relieve the stricture with the knife by one of the following processes.

Process of Hunter.—Draw the skin on the two sides away from the stricture so as to expose it fairly, and divide it by passing under its edge a sharp-pointed curved bistoury with its back to the glans. The incision has in some cases to be repeated at several points. This is not always easily accomplished, in consequence of the bulging crown of the swelled glans. I have in one instance succeeded completely in relieving the strangulation by this process, making use, however, of a dull pointed tenotome which I insinuated at several points between the body of the organ and the band. The parts were notwithstanding, in consequence of their infiltration, a long time in assuming their natural aspect.

Process of M. Velpeau. This surgeon divides the stricture from the cutaneous surface. He draws the skin of the penis backwards toward the pubis, while an assistant endeavours to revert the tumid mass forward, so as to render conspicuous the circular band of fibres that causes the strangulation. This band is to be divided at several points, by punctures through the skin with the point of the bistoury, which is to be held like a pen. The author of this process speaks highly of its advantages.

Process of Richter.—This consists in raising a fold of skin behind the stricture with a pair of forceps, incising the fold, and introducing from the opening a grooved director strongly curved at the end, under the margin of the narrowed prepuce, which is then to be divided with a knife run along the groove. Even after the strangulation is relieved by the division of the stricture, it will in many cases be found difficult to bring down the foreskin, in consequence of the distension of its cellular structure by a consistent albuminous effusion. I have, under such circumstances, as well as in the simpler forms of the disease in children,

found warm fomentations highly advantageous in soothing and relaxing the parts, and gradually rendering the prepuce movable.

When paraphimosis has been suddenly developed in gonorrhœa, as a consequence of acute œdema of the lower part of the prepuce, active antiphlogistic measures, with warm mucilaginous applications to the part, have in my hands sufficed in a short time for the cure.

CANCER OF THE PENIS.

When the prepuce merely is affected with cancer, the swelling of its loose cellular structure pushes the glands backwards, so that at first sight the body of the organ appears involved. It has been asserted by Callisen and Lisfranc, that cancer of this organ usually commences in the integuments, and remains so long without involving the fibrous involucre, as to enable the surgeon in some instances to extirpate the disease by the following process, without shortening the essential structure of the penis. But under any circumstances the operation for genuine cancer of the penis is, from the rapidity with which the glands of the groin and pelvis become involved, according to the experience of the author, one of the most discouraging in surgery.

Process of Lisfranc.—When the cancer is seated at the end of the penis, a longitudinal incision is to be carefully made over the back of the organ, through the whole extent of the affected portion, down to the involucre. If the involucre is not involved, the diseased tegumentary layers merely are to be dissected off. If there are any suspicious points upon the involucre, they are to be raised with the hook or forceps and carefully shaved away. If the body of the organ is invaded by the disease, it is necessary to resort to amputation.

Amputation. (PL. LXIII. fig. 4.)—This operation is chiefly required in cases of cancer, though it has in some few instances been deemed necessary for aneurism of the cavernous structure, and in instances of gangrene. In consequence of the great extensibility of the integuments of the part, and the tendency of the cavernous body to retract after division, the common rule in amputation of saving as much of the skin as possible, does not apply here, it being found most advantageous to divide both structures upon the same level.

Various processes have been devised, but the following will be found the most appropriate. An assistant, standing behind the patient, grasps the penis near its root between his thumb and finger, so as to compress its vessels. The surgeon takes in his left hand the diseased extremity of the organ, which should be covered with a piece of linen, and with a long-bladed bistoury in his right divides the skin immediately behind the limits of the disease. He then examines carefully into the condition of the body of the organ which is now exposed, and divides it as far forwards as the affection will admit, with one stroke of the knife, from below upwards. The divided arteries—the dorsal and cavernous of either side—are now to be drawn out and secured as under ordinary circumstances. Cold applications and slight compression will usually suffice to check the oozing from the spongy structure. A flexible gum catheter should be introduced into the bladder, for the double purpose of preventing the narrowing or closure of the urethral orifice, and keeping the urine from coming in contact

with the wound. The catheter is to be secured in its place with tapes, and the skin merely drawn over the stump and retained in place by two adhesive straps crossed in front.

HYPOSPADIAS.

This consists in a congenital malformation of the urethra, in which the canal opens, at some point on the under surface of the urethra before it reaches the glands. There are three varieties of this affection:—1, when the abnormal orifice is found behind the frenum, the fossa navicularis opening directly on the surface, the prepuce being cleft back beyond this pouch; 2, one in which the urethra opens at some point between the fossa navicularis and the scrotum; and, 3, when the scrotum is split in the median line, so as to form two portions like the labia majora of the female, and the urethra opens at the bottom of the fissure. The first two varieties alone afford any prospect of relief by operation.

First variety.—This is the one by far most frequently observed. It is seldom that any operation is called for *merely on account of the shortening of the urethra*; and such as have been proposed—the perforation of the under part of the glans with a trocar, retaining a catheter in the passage till the abnormal orifice can be made to close—or the splitting of the glans from the orifice outwards, and uniting the margins of the incision over a catheter introduced into the bladder—afford but little prospect of improving the patient's condition. In some instances, however, in consequence of the relative shortness of the corpus spongiosum compared with the cavernous body, the glans in erection is bent downwards at an angle so as to form a club-shaped extremity, thus rendering the subject of the defect virtually impotent. A deformity of this description was remedied by Dr. Physick by the removal of a wedge-shaped piece from the back of the corpus cavernosum by two sloping cuts with a razor. During the preceding winter I have, with the assistance of Professor Horner, been, in a case of much interest, completely successful in relieving a similar deformity by the following operation.

In the case alluded to the curvature was abruptly made just behind the junction of the glans with the point of the cavernous body. On a close examination of the organ it was found that it would be necessary, in order to raise the face of the depressed glans up to the level of the dorsal line of the cavernous body, to remove from the latter a wedge-shaped piece which should have the breadth of an inch upon the upper surface of the organ. As the glans receives its blood in a great degree from the arteries which advance to it along the corpus spongiosum, it was but little likely that its vitality would be endangered by the operation. The patient was seated in a chair. A longitudinal fold of the integuments was raised over the dorsum, and divided transversely by a bistoury entered at its base, about half an inch behind the corona. The divided portions of the integuments were then separated so as to expose the cavernous body. The cavernous body was next flattened by being grasped transversely with the thumb and finger, and a straight sharp-pointed bistoury passed across it at a distance of about a fourth of its thickness above the corpus spongiosum, and about three-quarters of an inch behind the glans. The bistoury by a sawing movement was then carried upwards and backwards in a slanting direction, so as to make the first

sloping cut on the side next the root of the penis. The bistoury was dropped again into the bottom of the incision, and a second sloping cut made obliquely forwards and upwards, coming out a little behind the glans. In making the last section the edges of the divided corpus cavernosum were steadied by a couple of pairs of forceps. Little bleeding took place, and that chiefly from the vessels of the divided prepuce. The glans was now raised, and it was found necessary to remove a thin slice more from the back of the corpus cavernosum, to give the organ its exactly natural form. The edges of the section of the corpus cavernosum were kept in apposition by three sutures on either side. The wound of the prepuce was closed in like manner. The organ was then placed in a hollow splint well padded, and secured in its position by a few light turns of a roller, and kept wetted with a cold astringent lotion containing some laudanum. At the close of the third day the dressing was removed. The wound of the corpus cavernosum appeared to have united by first intention. The prepuce, which was congenitally deficient at its lower portion, and had been deprived to a considerable extent of its vessels by the incision of the integuments, was found ununited, œdematous, and dark coloured on its middle line. In the course of three weeks the cure was complete; its protrusion to this period being owing chiefly to the separation of a slough on the upper surface of the prepuce, which did not, however, extend to the mucous membrane, and was in the end even beneficial in reducing the excessive dimensions of the prepuce. The glans penis at no time suffered either by a diminution in its supply of blood or nervous influence. The risk of gangrene of the prepuce might readily in a similar case be avoided by dividing the integuments on the side of the organ, and loosening the prepuce so as to turn it backwards and uncover the corpus cavernosum—a plan which I had first proposed in this case, but for various reasons was induced to change.

Second variety.—In these cases the portion of the urethral canal in front of the abnormal orifice is usually imperforate; though in some instances it may be found, even when the opening is far back, as in the case of a soldier reported by Marestin, that the canal is continuous up to the glans, terminating there in a cul-de-sac. In cases of the latter sort, a cure may be effected by the following process.

Process of Marestin.—This surgeon introduced a probe from the congenital orifice which existed in the perineum, and found the urethral passage obliterated at its extremity merely by a fleshy septum. He cut through the septum upon the end of the probe, and introduced a catheter into the bladder. The edges of the perineal orifice were then excised, and united by the hare-lip suture.*

In instances of this second variety of hypospadias, where the urethra is completely obliterated between the abnormal orifice and the end of the glans, the cure may be attempted by the process shown at Plate LXIII. figs. 2, 3, which was found successful in a case communicated to M. Bourguery by M. D'Aremberg, where the urethra opened by a cleft, half an inch long in front of the scrotum, through some thickened integuments which acted

* If the urethra in the infant be found simply imperforate, as sometimes happens, it may readily be opened by a puncture with a bistoury when distended with urine.

as a bridle in keeping the penis drawn downwards. The mode of operation will be well understood by reference to the plate.

Dr. J. P. Mettauer, of Virginia, has recently reported the cure of a highly interesting and complicated case of hypospadias of the second variety. The penis was of unusual length; the anterior three-fifths of it consisted of the integuments, the glans, and an expanded and non-erectile portion of the urethra capable of containing two ounces of fluid which was appended to an erectile stump forming the posterior two-fifths of the free portion of the organ. The first step of the process consisted in laying open the pouch of the urethra on the rapheal line, removing from the interior of the cavity a belt seven lines in width, consisting merely of the urethral wall, immediately behind the base of the glans. A similar belt was then removed immediately in front of the end of the erectile stump. Upon the end of this stump, which was carefully denuded, the glans was transplanted and attached by "eight points of the glover's suture." On the third day union had taken place between the glans and the stump. The unsightly fold of integuments left by the shortening of the organ in thus transposing the glans, was reduced to the proper dimension by excision three months after the first operation. Several months after this the third step of the operation was completed—that of opening a new passage for the urethra with a trocar, introducing a catheter, and closing the abnormal orifice in the perineum. The closure of this orifice was accomplished by a process which Dr. M. has employed with advantage in many other cases—that of cauterizing the surfaces with *argentum nitratum*, scraping away the eschar, and immediately uniting the parts with the interrupted suture.*

EPISPADIAS.

The congenital deformity distinguished by this appellation is much less frequently observed than the preceding. It consists in the termination of the urethra by an orifice on the back of the penis arising from the imperfect development of the upper surface of this organ; or of an unusual prolongation of the crura of the penis, the urethra ascending in the form of a gutter between them. The affection may be considered incurable.

When the epispadias is accidentally developed, there is a better prospect of cure. I have lately had under my charge a patient in whom, in consequence of a destructive chancreous ulceration of the glans and inner surface of the urethra, the passage of the latter had been obliterated for some distance back from its external orifice, and a new rout established for the urine by the way of the cellular structure of the cavernous body of the penis, which was distended by every effort at micturition—two ulcerated openings in the involucre, one at the top and the other at the anterior portion of the organ, having been formed for the escape of the fluid. In this case I proposed to open the urethra in the perineum, and make an effort to restore the passage with a trocar, nearly as in the process exhibited in Plate LXIII. But on cutting down just in front of the bulb, I found the urethra completely obliterated even at this point; and as it was impossible to tell whether the fistulous communication with the corpus cavernosum had not been made back as far as its crura, this project was abandoned. As the necessity of some mode of relief was urgent, and as the

glans had already been destroyed, I determined to amputate the end of the organ, for the double purpose of getting rid of the lumpy and knotted end formed by the irregular union of the prepuce with the stump, and of opening a free rout for the escape of the urine from the cells of the corpus cavernosum. The success of the operation which was performed before my class during the winter of 1844-5, was complete. The end of the organ was removed with the catling at one stroke from above downwards and forwards. The urine spurted out by two streams, which appeared to occupy the site of the cavernous arteries. Through the larger of these openings, a small gum catheter without a stilet was passed, directly into the bladder. By gradually increasing the size of the catheter, a new large-sized urethral canal was formed through the corpus cavernosum; this became lined with a mucous membrane, completely shut off the urine from the surrounding cells, and after being kept dilated for three months, showed no tendency to close. The stump of the organ was left about an inch and three quarters in length, in front of which the loose skin of the penis formed a sort of a prepuce.

OPERATIONS ON THE URETHRA AND BLADDER.

These comprise—Operations for stricture of the Urethra; for Retention of Urine; and those for Stone.

STRICTURE OF THE URETHRA.

No class of surgical diseases demands more attentive study on the part of the practitioner than that which involves as one of its consequences a retention of urine. The lining membrane of the urethra is directly continuous with the internal mucous lining of the bladder, the ureter and the pelvis of the kidneys, with the ducts of the prostate, the vesiculæ seminales, the vasa deferentia, and the glandular substance of the testes, all of which parts are in consequence liable, in ill-managed cases of recent or old stricture, to become diseased. The morbid sympathies of these parts with the rest of the economy are, moreover, direct and extensive—and from them may in many cases be traced derangement of the digestive organs, paroxysms stimulating intermittent fever, functional derangement of the heart, and extreme moral depression.

Strictures of the urethra are commonly classified under three heads—the *acute or inflammatory*, the *spasmodic* and the *organic or permanent*.

As regards the pathology or general methods of cure of these various affections, the limits of this work will not allow me to treat. It must suffice here briefly to observe, that the common cause of the acute or inflammatory stricture is gonorrhœa, though the affection may also arise from the introduction of rough or pointed instruments into the canal, from the passage of fragments of calculi, or from a kick or blow in the perineum. The more usual seat of this stricture is at the curve, though it may be met with at any part of the canal. The measures to be relied on mainly for its cure, consist in the employment of appropriate general and topical medical treatment, as in the case of any other local inflammation.

The *acute* or the *inflammatory* is the common cause when not thoroughly cured of the two succeeding varieties of stricture.

* Vide Amer. Journ. of Med. Sciences, July, 1842.

From the inflammation developed in it, the mucous membrane is not only rendered turgid, but has its sensibility highly augmented, so that the contact of the urine as it passes through the narrowed portion of the canal near its curve, produces a sensation of heat or burning. This occasions the urethral or perineal muscles to be thrown into spasmodic action, by which the calibre of the passage is still further diminished, and the jet of urine becomes feeble, small, and at times completely interrupted. In this way the inflammatory and *spasmodic* strictures are often seen in a state of combination. The spasm may occur suddenly, when, in an inflammatory affection of the internal part of the urethra, an attempt is made to pass a bougie rudely along the membranous portion—or even in the act of micturition when the urine is rendered acrid and irritating by a superabundance of lithic acid or phosphatic gravel, or by the absorption of cantharides, or the profuse administration of terebinthinate or balsamic preparations: or it may even arise from the simple voluntary retention of the healthy urine for an unusual period, during which the intentional resistance made with the sphincter muscles against the continued efforts of the bladder, becomes in the end converted into a state of spasm. The treatment of these cases of spasmodic stricture must likewise, as in the preceding variety, be in a great measure merely medical, the practitioner recollecting that to the inflammatory there is added a spasmodic element of disease, to be met by the additional use of opiates, warm baths, fomentations, &c., commonly directed under such circumstances. It is only in extreme cases of this description, rarely met with, that instrumental interference beyond the cautious attempt to introduce a catheter—such as cauterization of the passage in front of the stricture, or the tapping of the bladder—can be deemed justifiable.

In every case of much severity, the inflammatory swelling of the mucous membrane of the urethra extends to the submucous cellular tissue, and very frequently to the membranous and spongy structures on its outer side, and is attended with an effusion of blood and serum which in the end may be replaced by lymph, so as to produce an *organic* or *permanent* stricture. If the lymph effused either in the mucous membrane or in the submucous tissue, extend even half an inch or two inches along the passage, the swelling will be found greatest in the centre, declining gradually to the anterior and posterior boundaries of the inflammation. It may extend to the whole circumference of the urethra, or be limited merely to a segment of its wall. But in either of these cases, the mucous membrane will be found projected inwards in the form of a valvular swelling, constituting either a circular rim, or a segment of a circle forming a kind of bridle. If the disease is not managed with sufficient attention in its early stages, and with forbearance and delicacy in reference to the use of bougies and cauterizing instruments—a matter in which the most grievous errors are but too commonly committed—the effused lymph will become solidly organized, so as to make its removal a work of considerable time and difficulty. It is in cases of organic or permanent stricture that the following processes have been particularly directed, the use of which should at the same time be aided by appropriate general treatment. These consist of *dilatation* in the various ways in which it is practised, *cauterization*, *scarification*, and *incisions* made either from within the urethra or from without.

The last three of these methods cannot, however, be used ex-

clusively in any case—it being necessary to employ dilatation in conjunction, for the purpose of producing a flat cicatrix which shall leave no prominence in the urethral passage. It may also be well to observe, that in a great majority of cases the judicious employment of dilatation will suffice without either of the other processes, to restore the urethra to its natural dimensions. Stricture, as has been observed, may occur at any portion of the urethral canal, though its more ordinary seat will be found at the region of the curve, which is the most sensitive part of the passage, and the most narrow, with the exception of the external orifice. From the uncertainty that may exist in regard to its precise seat, it becomes necessary to resort to the most direct means of diagnosis. The sound or bougie is commonly employed for the purpose of exploring the passage. The exploration, however, requires to be done with such lightness and delicacy of touch, especially in diseased states of the passage, that it needs a practised hand to perform it with entire safety to the patient, and to draw from it the proper therapeutic indications. For if the exploration be made roughly, or with unsuitable instruments, or persevered in at improper times, the suffering from the affection may be greatly aggravated. If a bougie does not readily enter the bladder, it does not necessarily follow that there is a stricture. It may be arrested by spasm—its point may catch in one of the lacunæ of the passage or hitch against the edge of the triangular ligament—or there may be some swelling of the prostate, or some tumefaction or abscess of the perineum which has caused a narrowing of the canal. Mistakes have in these respects been frequently committed, and patients subjected to treatment for imaginary strictures—and especially by the popular process of cauterization—so as to occasion much disorder of the urethra, and not unfrequently lay the foundation of a real stricture, or some disease of the prostate or bladder that may be entailed on the patient for the remainder of his life.

The exploring sound of Ducamp (Pl. LXIV. fig. 3), has been devised for the purpose of taking an impression of the stricture. This *porte-empreinte*, or impression taker, consists of a graduated flexible catheter, made open at both extremities, though the anterior is left smaller than the other. A small skein of silk, knotted at one end, is passed through the tube and out at its anterior extremity till the knot becomes arrested at the terminal orifice. The skein is then detached, leaving the divided ends of the threads projecting about half an inch beyond the end of the canula. These are knotted together, trimmed into the form of a pencil, and steeped in a mixture made of equal parts of yellow wax, diachylon, shoemaker's wax, and white rosin. The sound thus prepared is carried down to the stricture, allowed to rest a moment till the material at its end becomes softened, and is then pressed gently and steadily against the face of the contraction. The softened wax penetrates into the cavity of the stricture, and on the withdrawal of the instrument brings away a tolerably accurate mould of the part *against which it has been pressed*. The advantage of this instrument, in the opinion of the author, has been greatly overrated—as it gives rise to considerable pain and irritation, and is often arrested at a wrong point, or gets bent in the passage, so as to bring away a false print.

Sir Charles Bell employed a small silver stilet, terminated at the ends by balls of various sizes like the gunshot probe, for the pur-

pose of ascertaining the seat, extent, and number of the strictures. It is to be passed down to the stricture to ascertain its anterior termination, and the same, or one with a smaller head, passed through the narrowed portion and retracted again so as to hitch against the back margin of the stricture, for the purpose of determining its posterior boundary. This process of exploration is, however, attended with much pain, and is liable from the spasm it excites to impair the accuracy of the diagnosis.

The exploring sound devised by Amussat is more simple than the preceding. It consists of a silver canula terminated by a mobile lenticular-shaped button. The cavity in which the stilet turns that moves the button is not in the centre, but nearer to the outer margin of the instrument. The stilet is soldered to the heel of the button, so that in turning the stilet the button, which previously covered smoothly the end of the instrument, revolves so as to project on the opposite margin of the canula. The instrument is introduced, closed, up to the prostate; the button is then made to project, and, as the instrument is slowly withdrawn, it catches against the posterior end of the stricture. The value of this instrument the author believes has been over estimated; it may lead to erroneous diagnosis, either by the bar not being turned upon the side of the stricture and thus missing it altogether, or by its hitching up some fold of mucous membrane, which does not actually constitute a stricture.

The wax or plaster bougie will, according to the experience of the author, be found the least irritating and most serviceable instrument. It should be slightly warmed, and a little curved at the end by being rubbed between the thumb and finger, well oiled, and introduced slowly and gently. After having been pressed steadily, but with little force, against the face of the stricture, it may be withdrawn, and will bring away a mould of the narrowed part sufficiently accurate for all purposes; the distance of the stricture from the orifice being ascertained by the extent to which the urethra has received the instrument.

Dilatation.

This is commonly effected by the use of bougies, which are formed of different materials. Those in most common use consist:—1. Of the *wax or plaster-cloth* bougie, the cloth being cut into strips of the proper size and rolled into form between two hard and polished surfaces. 2. Of *gum elastic* instruments, which may either be solid or hollow, though the latter kind is usually preferred. 3. *Catgut or gelatinous* bougies: these are of small size, and are intended merely for the permanent dilatation of the narrowest kind of strictures, which the bougies formed of other

materials cannot so readily be made to pass. 4. Bougies *made of the bark of the American elm*. These have within a few years past been introduced and employed with much success by Dr. McDowell, of Kentucky. In the hands of the author they have not, however, appeared to possess any peculiar advantage. 5. Of *ivory*, softened by a chemical process, the introduction of one of which is shown at Plate LXIV. fig. 1. 6. *Metallic bougies*: these are made of flexible metal, of silver, gold, platina, or steel plated with silver. The flexible metallic bougies are not susceptible of high polish, and therefore objectionable. If small, they are apt to bend in using, so as to worry and irritate the passage. The silver bougie, highly polished, will be found the most useful of this class. They are, however, according to the author, better fitted for diminishing the irritation of the passage and for completing the cure, (which should be commenced with other instruments when the passage is much narrowed,) and especially for preventing the recurrence of the stricture, as this is to be looked for even after the narrowing appears to have been entirely effaced by the previous treatment.

The mode of using these instruments may be understood by reference to the various treatises on this subject, and to the representations in the plate. It will be necessary here merely to observe that,

Temporary dilatation is effected by introducing a bougie of such size through the stricture as to give a sensation of tightness, at intervals of one, two, or three days, according to the degree of irritation which it appears to excite, allowing it to remain from ten minutes to half an hour at each time. At each successive operation the size of the bougie is to be gradually increased in proportion as the narrowing yields. This is the process which in ordinary cases is found the most successful.

Permanent or continuous dilatation.—This consists in the introduction of a bougie or catheter of the largest size that can by a slight effort be made to pass the stricture, leaving it for hours together in the passage, and then withdrawing and immediately replacing it by one of somewhat larger size. When the stricture is exceedingly narrow, it may be possible only to pass a catgut or gelatine bougie of the smallest size; these, by their imbibition of moisture, quickly swell and dilate the narrowed passage, and must be withdrawn and replaced by another when the desire of micturition becomes urgent. In all cases where a catheter even of small size will pass, this is to be preferred, as it will allow the urine to flow through it, and may be kept in for twenty-four hours together. At the end of this time it will be found loose in the passage, when one of somewhat larger size is to be substituted. By repeating

PLATE LXIV.—OPERATIONS ON THE URETHRAL CANAL.

For greater clearness, all these operations are represented on a section of the pelvis.

Fig. 1.—*Gradual dilatation of a stricture*, with the flexible ivory sound.

Fig. 2.—*Forced dilatation*, with the three-branched dilator. The branches are separated by a mandrin or stilet passed down the interior of the instrument.

Fig. 3.—*Impression of a stricture*, taken with the *porte-empreinte* of Ducamp.

Fig. 4.—*Cauterization*, with the instrument of Ducamp.

Fig. 5.—*Cauterization*, with the instrument of Lallemand.

Fig. 6.—*Scarification*, with the instrument of M. Leroy d'Étiolles.

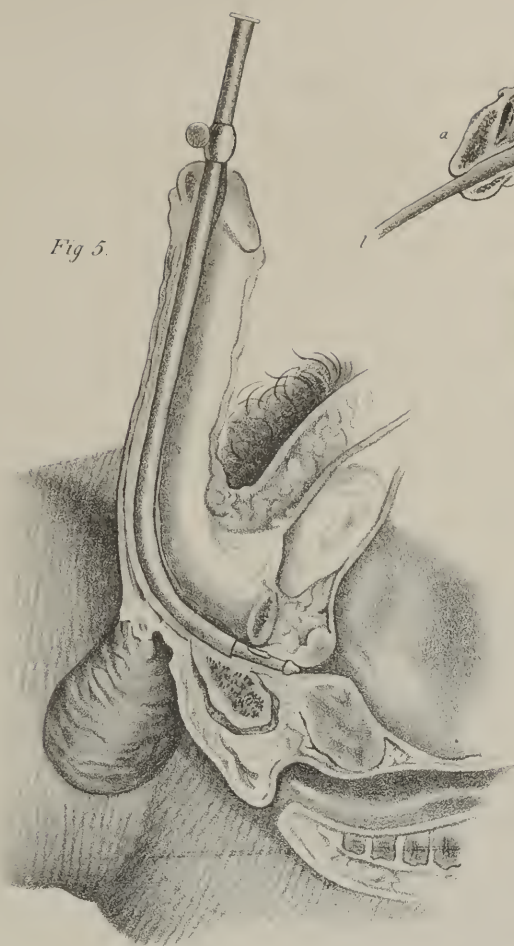


Fig. 5.



Fig. 1.



Fig. 3.

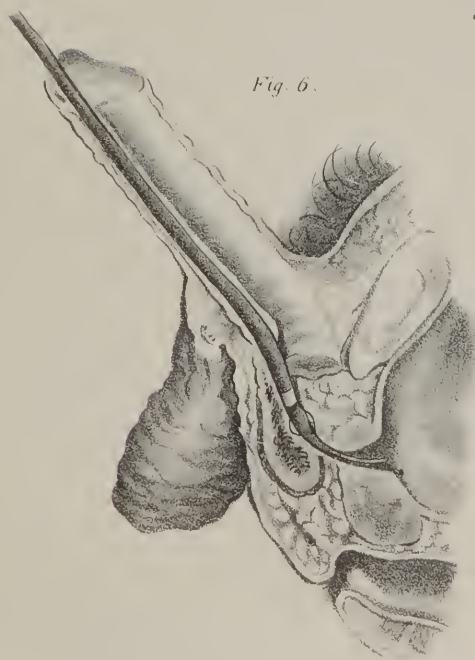


Fig. 6.



Fig. 2.

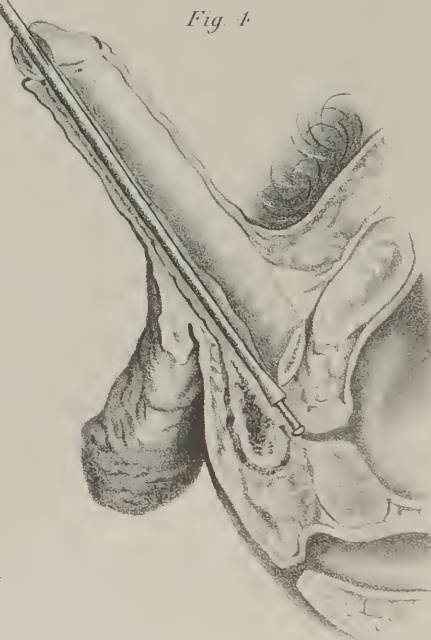


Fig. 4.

this process, we may often in a short time succeed in restoring the passage to its natural dimensions. The principal objection to this process (and it is one of much moment), is the fear that the continual presence of the instrument, and the pain and irritation it occasions, may excite inflammation of the testicles or bladder, and in the end, if persevered in when these symptoms of intolerance to its use exist, an extension of the disease to the ureters and kidneys. In many instances, however, it will be found useful to commence the dilatation by this means, and complete it by the temporary use of instruments.

Vital dilatation.—This consists in the employment of a large silver sound, in cases where there is an organic stricture accompanied with so much spasm as to prevent the introduction of small instruments. The sound or bougie is to be pressed against the stricture daily for a quarter or half an hour, by which means we may in some instances so diminish the sensibility of the part, or soften it by the excitement of a muco-purulent discharge, that a small bougie or catheter may be passed. Dupuytren even advised their being held pressed against the stricture by strings or springs, and gradually advanced as the parts were found to yield. This mode of employing the bougie has, however, been received with but little favour.

Forced dilatation.—This consists in an attempt to overcome the stricture by a sudden effort. A variety of means have been resorted to for this purpose: Forced injections (*Amussat*) have been employed in cases of retention of urine following stricture, on the belief that the narrow opening was clogged up with mucus or blood; a three-branched dilator, (Pl. LXIV. fig. 2,) in which the distension is made by passing down through the canula stiletts of gradually increasing size; a solid sound (*Mayor*) introduced down to the stricture and forced on in the direction of the natural passage; a director (*Arnott*) made of a tube of varnished silk, which is to be introduced into the stricture and then distended with air impelled into it with a syringe. Though these various measures have occasionally proved successful, they are generally proscribed, on account of their liability to occasion rupture or laceration of the urethra, or the formation of false passages, and from the fact that greater success is attendant upon the judicious employment of the processes of dilatation above noticed.

Cauterization.

The practice of employing cauterizing substances in the urethra for the cure of stricture is of ancient date. It has been revived, practised extensively, and much abused in modern times. The nitrate of silver is the caustic commonly used, in consequence of the greater certainty with which it may be applied to the diseased spot. Mr. Whately, (who has had but few followers,) gave, however, the preference to the caustic potash, a minute piece of which may be employed pure or diluted with soap. The cauterization may be made from before backwards upon the face of the stricture, as in the manner of Wiseman and Hunter—or from within the stricture outwards, as in the process devised by Ducamp and modified by Lallemand.

Cauterization from before backwards.—The practice of Hunter as improved by Home, consisted in arming an ordinary large wax bougie, by inserting into the centre of its entering end a small piece of lunar caustic. The end of the instrument was pressed

for an instant against the stricture, and then withdrawn. This process, which was much lauded for a time, occasioned in many instances irreparable mischief. It was found impossible to confine the action of the caustic so as to prevent the injury of the walls of the urethra anterior to the stricture, and in cases where this was seated at the curve, hemorrhage was no uncommon result from its use, in consequence of the caustic burning into the structure of the bulb.

Cauterization from within outwards. (*Process of Ducamp.* Pl. LXIV. fig. 4.)—The improvement suggested by this surgeon consisted in taking a mould of the stricture with an exploring bougie, (Pl. LXIV. fig. 3,) and passing down subsequently a complicated instrument, called the *porte-caustique*, to the face of the stricture. A little cup attached to the stilet of the instrument, containing the caustic porphyryized over the flame of a candle, was then projected from the instrument into the stricture so as to effect the cauterization of its inner surface. This process is more beautiful in theory than easy in practice. It is difficult to hit exactly the narrow orifice—the end of the instrument being apt to hitch against the margin of the stricture, press it backwards or even rupture the membrane, and defeat the object by confining the action of the caustic to the healthy portion of the canal.

Process of Lallemand. (Pl. LXIV. fig. 5.)—This is a decided improvement over that of Ducamp. The instrument employed is a cauterizing sound, straight or curved according to the portion of the urethra on which it is designed to act, constituted much on the same principles as that of Ducamp, with the exception that it is designed to *pass the stricture, and allow the caustic cup to be brought in contact with the inner surface of the stricture, not by pushing the stilet forwards, but by retracting the canula.* It is evident, however, that the cavity of the stricture for this purpose must be of a size that would allow of the introduction of a wax bougie, an instrument that passes more readily than any other, so as to render the cure practicable by the process of dilatation. Even by the methods of Ducamp and Lallemand, a final resort has always to be made to the bougie to effect the cure. Great contrariety of opinion has existed in regard to the degree to which the action of the caustic should be carried. Some have applied it boldly, believing that it may do good by the detachment of a slough, so as physically to enlarge the opening. Others direct its slighter application, for the purpose merely of modifying the vital properties of the membrane—by diminishing the exalted sensibility of the part, softening the tissue by exciting a purulent discharge, and thus preparing the way for dilatation. In the latter sense, the author has found it in numerous instances highly advantageous, and to this he believes its use in stricture should be altogether limited. Several cases have come under his notice, where, from the boldness of the application, or its too frequent repetition, the stricture has been rendered more callous and resisting, and a chronic inflammation developed in the mucous lining of the prostate, bladder, spermatic ducts, and testicle, producing a complication of disease exceedingly difficult to eradicate.*

Incisions and scarifications from within the urethra.—These are ancient processes which, with some modifications, have been re-

* The ancient process of employing medicated bougies has been to a certain extent revived by Jobert, Bretonneau, and Velpeau. The medicating material which these surgeons have chiefly employed, is powdered alum.

vived and practised to a considerable extent by many surgeons. Dr. Physick devised an instrument from which a lancet, cutting on its lower edge, could by means of a stilet be projected from the entering end. The instrument was straight or curved according as the object was to divide the stricture at the straight or curved portion of the urethra. A variety of instruments have been devised for this purpose, of which it may suffice to mention those of Chew, Amussat, and Leroy.

The ingenious instrument of Dr. Chew, (late of New Orleans,) made in this city by Mr. Shively in 1828, consists of an ordinary silver sound, either straight or curved, and split at the entering end, so that an elliptical double-edged knife can be protruded for a few lines by pushing on a button which is attached to the stilet of the instrument. The point of the knife is blunt, and pierced for the passage of a silver wire. The wire is to be introduced from the anterior end of the instrument, and is arrested at the point of the knife by a rounded head, its other extremity projecting at the opposite end of the sound. The mode of using it is as follows. The instrument, with the knife retracted and the probe end of the wire closely drawn up to the blade, is carried down to the stricture. The probe head of the wire is then gradually pushed on separately through the stricture, which it readily passes on account of the central position it necessarily occupies in the canal. The probe point of the wire may be carried on even into the bladder. The knife, guided in the right direction by the wire, is next pushed on and the stricture divided. As soon as the division is made, the knife is retracted and the body of the instrument carried forwards. If one or more additional strictures are encountered, the same process may be repeated for each. In this way I have repeatedly divided several strictures in the same subject at one sitting, and completed the operation by passing at once, on the withdrawal of the instrument, a moderate sized catheter into the bladder. The cure is to be finally completed by the process of dilatation. This is a speedy and efficacious method. No inconvenience has followed in my hands save in one instance, when it gave rise to a sympathetic inflammation of the testicle. In irritable subjects it would, however, be attended with danger. Death followed its use in the hands of a surgeon formerly of this city.

Three instruments have been devised by Amussat, the peculiarity of which consists in their cutting upon a sliding oval button, which is made to hook behind the stricture. 1. One called an *urethrotome*, consisting of a conical steel cylinder a little more than half an inch long, armed with eight longitudinal cutting crests, projecting to the extent of a quarter of a line from the surface. This is carried down upon a mandrin previously passed through the stricture, and the incision made from before backwards. 2. One called a *bridle cutter*, (*coupe-bridle*,) resembling the exploring sound of the same surgeon, described at page 324, with the exception that the end of the canula corresponding to the button, is sharp and intended to effect the excision of the bridle or mucous fold, by being pushed from before backwards upon the button. 3. One more complicated than the other two, consisting of a canula cleft laterally for about half an inch at its anterior extremity for a sliding semicircular blade, and notched upon the opposite side to the depth of a quarter of an inch, to accommodate the rod which moves the little bar at the end. The instrument with the knife

concealed is carried down to the narrowed part. The oval bar is first pushed on with the rod, and then retracted so as to hitch against the bridle. A turn is then given to the canula in order to bring the knife upon the same side with the fold, which is to be divided by pressing the blade from before backwards against the bar. A variety of other instruments have been devised for incision and scarification. The one most used by Leroy d'Etiolles, is shown in action at Pl. LXIV. fig. 6.

Incision from without inwards.—This is particularly appropriate to cases of old stricture near the curve, through which, from the morbid alterations of the part, no instrument can be passed, and especially if complicated with fistulous openings in the perineum by which the urine in part or altogether escapes. In the latter case, an attempt should be perseveringly made to dilate the perineal sinuses, so that a probe may be passed up to the bladder; a guide of this description will greatly facilitate an operation that otherwise will, in certain states of the part, be found one of the most difficult in surgery.

The patient is to be placed in the position for the lateral operation for stone. A moderately curved silver catheter is then to be passed down to the stricture, and firmly held in the middle line by an assistant. If there be no callous growths or thickening of the tissues, the point of the sound may be felt in the perineum, so that the surgeon can cut directly down upon it. If the point cannot be felt, the difficulties are much increased. The surgeon is then to divide the parts in the middle line, and should have a perfect knowledge of the anatomy of the region. The urethra is to be opened on the end of the sound in front of the stricture. A small director is then to be passed through the stricture up to the bladder, and the stricture itself divided with a probe-pointed bistoury. The sound is then to be passed on to the bladder, and the operation is completed. If there has been an urethral fistula, through which a probe could be passed into the bladder, it will be necessary to divide the bridge between the probe and the end of the catheter. If the orifice of the stricture is so small that it cannot be detected after the deep incision of the perineum—the fistulous tracts so sinuous as to prevent the introduction of the probe—and the structure of the perineum callous and irregularly tumid, as has been the case in five instances in which I have successfully performed this operation, the following course is to be pursued, which is much the same as the one detailed by Mr. Shaw. The lips of the wound are to be well separated and sponged clear of blood. The patient is now directed to urinate, and the surgeon carries a probe into the bladder from the point at which the urine escapes. If the patient is so agitated as to be unable to expel any urine, or to distend the urethra so that it may be felt from the wound, or the bladder is empty in consequence of a previous inability to retain the urine, there are two courses to be pursued: the operation may be deferred for an hour or more, till the flow of urine can be detected in the wound, or the surgeon is to proceed at once and cut by his anatomical knowledge in the direction of the passage towards the bladder. The author has practised both these plans, the former of which is ordinarily to be preferred. But if the case be one of great suffering from retention of urine, the latter course is to be pursued. The incision is to be carried backwards and upwards in the middle line, and if the urethra behind the stricture be, as is usually found the case, dilated to two

er three times its natural extent, it will, as soon as it is tapped with the knife, give rise to a gush of urine. But in case there be retention without this expansion of the urethra, I have found it most advantageous, when the membranous portion was too much disorganized, to be discovered by dissection behind the bulb, to tap the urethra and the prostate by an incision from within outwards as directed by Sir. C. Bell. This is accomplished by introducing the left fore finger through the anus up to the prostate, and passing up from the wound a curved sharp-pointed bistoury exactly in the direction of the passage, keeping it about a quarter of an inch above the finger so as to clear the rectum and strike the front part of the prostate, and then depressing the handle of the knife so as to make a tolerably free incision as the point is withdrawn. The urine may now be discharged, and a grooved director or probe should be entered as it flows, to serve as a guide for the passage of the sound into the bladder. In one instance only out of five have I failed to pass up the sound at once. When this cannot be accomplished, the sound is to be brought out at the perineal wound, and, a short catheter well secured externally, passed from the same point up to the bladder. At the first dressing of the wound, the sound itself may usually be slid in on a director. The perineal wound should be healed over the silver sound, which is to be withdrawn for the purpose of cleansing on the sixth or seventh day, when the incised portion of the urethra will be found sufficiently patulous to allow of its re-introduction, provided this be effected before the patient makes any change in his position. In case it should be necessary to withdraw the catheter at an earlier period, the conducting sound of Amussat will be found a useful instrument in replacing it. The healing of the wound will usually take place in from two to three weeks. In one of the five cases above alluded to, death took place from diarrhœa a month after the complete healing of the wound. On dissection, the kidneys were found disorganized from a chronic affection, but the new-made membranous portion of the urethra, (the specimen of which I have now in my possession,) was lined with mucous membrane, and with the exception of its being of a dark hue, presented a perfectly natural appearance.

PUNCTURE OF THE BLADDER.

This is an operation required but rarely, and only in cases of complete retention of urine which have withstood every judicious effort for relief by other measures, and are attended with imminent danger of gangrene or rupture of the bladder, or a fearful state of nervous prostration. The causes of the retention commonly consist either of stricture of the urethra, enlarged prostate, or morbid growths at the neck of the bladder. In addition to these may be mentioned, as an occasional cause, extensive inflammation or swelling resulting from accidental injuries of the perineum. In reference to the retention following urethral strictures, the process of incision from the perineum, just described, will be found usually more appropriate than any of the methods of tapping the bladder recommended in these cases, inasmuch as it is attended with less danger to life, and affords a prospect of removing at the same operation the accumulated urine, and the evil which has occasioned its retention.

In cases of retention from other causes, there are three methods

of puncturing the bladder more or less employed by surgeons:—
1. Puncture through the prostate from the urethra: 2. Puncture from the rectum: 3. Through the linea alba above the pubis.

Puncture from the urethra through the prostate.—This was made by Boyer with blunt instruments, and denominated *forced catheterism*.

Process of Boyer.—The patient is to be laid upon the left margin of the bed. A medium-sized conical silver catheter, slightly curved near the point, with a stilet sufficiently large to fill its cavity and keep it from bending, is to be passed down the urethra to the seat of obstruction. The surgeon then carries his left fore finger into the rectum till he feels the end of the catheter through the walls of the bowel. He next extends the penis upon the catheter, and, grasping the latter between the thumb of the right hand and the radial margin of the fore finger, which should be half flexed, pushes on the sound with a degree of force proportioned to the resistance encountered, as much as possible in the direction of the urethra, keeping the instrument exactly in the median line. As the instrument advances, the outer end is to be depressed toward the thighs. The finger which is retained in the rectum serves as a guide to the instrument, and may aid by elevating the point so as to give it a right direction through the prostate, whether it merely re-opens the natural passage which is the object proposed in the operation, or makes a new one, as is not unfrequently the case, through the substance of the enlarged gland. The depth to which the instrument penetrates, the facility with which the outer end can be depressed between the thighs, and the flow of urine after the withdrawal of the stilet, are the signs that the catheter has entered the bladder.

Process of Lafaye. (Pl. LXV. 5.)—The sole object in this process, which is older than the preceding, is the perforation of the gland. It is practised precisely as in the preceding process with the exception that the catheter is to be converted into a curved trocar, the stilet of which terminates in a triangular point capable of being projected a quarter of an inch beyond the canula, when the instrument is brought in contact with the gland. With the projection of the stilet, the whole instrument is advanced till it enters the bladder. The stilet is then withdrawn. The canula is retained for ten or fifteen days in the bladder, when it may be removed and replaced by one of larger size, for the purpose of establishing an artificial canal. The outline drawings in Plate LXV. show the necessity of holding the instrument in the proper direction, to avoid a puncture of the prostate at its upper or lower border, or even of missing altogether the cavity of the bladder—an accident which might readily occur to one not thoroughly familiar with the anatomy of the parts.

Puncture through the rectum. (Pl. LXV. 1, 2, 3.)—On the lower and posterior surface of the bladder, at the distance of half an inch above the upper border of the prostate (*when the gland is of its natural size*), will be found a triangular space bordered on either side by the vasa deferentia and vesiculæ seminales, and above, by the bottom of the peritoneal pouch formed between the bladder and the rectum. This portion of the bladder, in cases of extreme retention, is found depressed towards the cavity of the rectum, and if the prostate gland is not at the same time unusually enlarged in its antero-posterior diameter, may be readily reached with the finger. At this triangle, which is sufficiently large to be

readily struck with the trocar, the bladder and the rectum are so intimately united by dense cellular tissue, as to render it little likely that the urine will escape by infiltration between their walls after the operation.

Operation.—The instrument commonly employed is the canulated trocar of Fleurant, four to five inches long, and curved so as to form the segment of a circle of eight inches diameter. The stilet or trocar proper of the canula terminates, as the latter name imports, in a triangular point. The author believes, however, from the result of two operations on the living subject, that a lancet-pointed stilet, as recommended by Dr. Watson, would be less liable to be followed by inflammation of the mucous lining of the bladder.

The patient is to be placed as in the lateral operation for stone. The surgeon then introduces the left fore finger as far as possible into the rectum, till he can distinguish clearly with the point the fluctuating tumour formed behind the prostate by the lower fundus of the bladder. On the front or palmar surface of this finger the trocar with the point retracted within the canula is carried up and firmly pressed against the bladder at the distance of an inch behind the prostate, and exactly in the middle line. The outer end of the canula is then depressed, so that the anterior portion of the curve shall move in the direction of a point half-way between the umbilicus and the symphysis pubis. The stilet is then thrust forwards by pressure with the thumb, as shown in the drawing, and carried—the canula advancing with the same effort—for an inch and a half into the cavity of the bladder. The surgeon now withdraws his finger from the rectum, retracts the stilet, and discharges the fluid. In most instances the trocar is to be retained in the wound till the natural rout for the urine is restored—or at least

for one, two, or three days, so as to diminish the tendency of the orifice to close on the withdrawal of the instrument. It is to be secured with tapes passed through the loops in its shield, and attached to a bandage round the pelvis. The edges of the inner orifice of the canula are liable to irritate the lining membrane of the bladder after the escape of the urine. This should be avoided by the introduction of a second silver canula, terminating like the ordinary urethral sound, through the interior of the first. Great inconvenience, however, arises from the tenesmus excited by the presence of the instrument in the rectum, or in the attempt to assume the vertical position. When the inconvenience thus occasioned is great, a gum elastic catheter might be introduced through the canula and the latter wholly withdrawn.

Puncture above the pubis. (Pl. LXV. 4.)—When the bladder is distended with urine it rises above the pubis pushing the peritoneum before it, and brings itself in contact with the linea alba and the rectus and transversus muscle of each side. The tumour which it forms gives a dull sound on percussion, and the fluctuation of the fluid within may at times be felt. The patient should be placed upon the right side of the bed, with his shoulders elevated and his thighs slightly flexed. The usual place of puncture is in the linea alba, at the distance in the adult of an inch and a half above the symphysis pubis. The instrument directed in the preceding operation, though a little longer than necessary, will suit for the puncture above the pubis. The operator merely places the nail of the left fore finger over the linea alba, or, if the patient be extremely fat, divides the integuments previously by a longitudinal incision an inch to an inch and a half long, and, taking the trocar in his right hand, enters it with its cavity turned towards the pubis, as shown in the drawing, and the point in a

PLATE LXV.—PUNCTURE OF THE BLADDER.

Surgical anatomy of the bladder.—The walls of the abdomen and pelvis have been removed on the left side, a portion of the bladder excised, and the penis and prostate cut through on the middle line. The prostate is represented greatly enlarged, especially at the middle lobe, so as to have caused a retention of urine, as shown in a preparation of the author taken from a patient who had died of this affection.

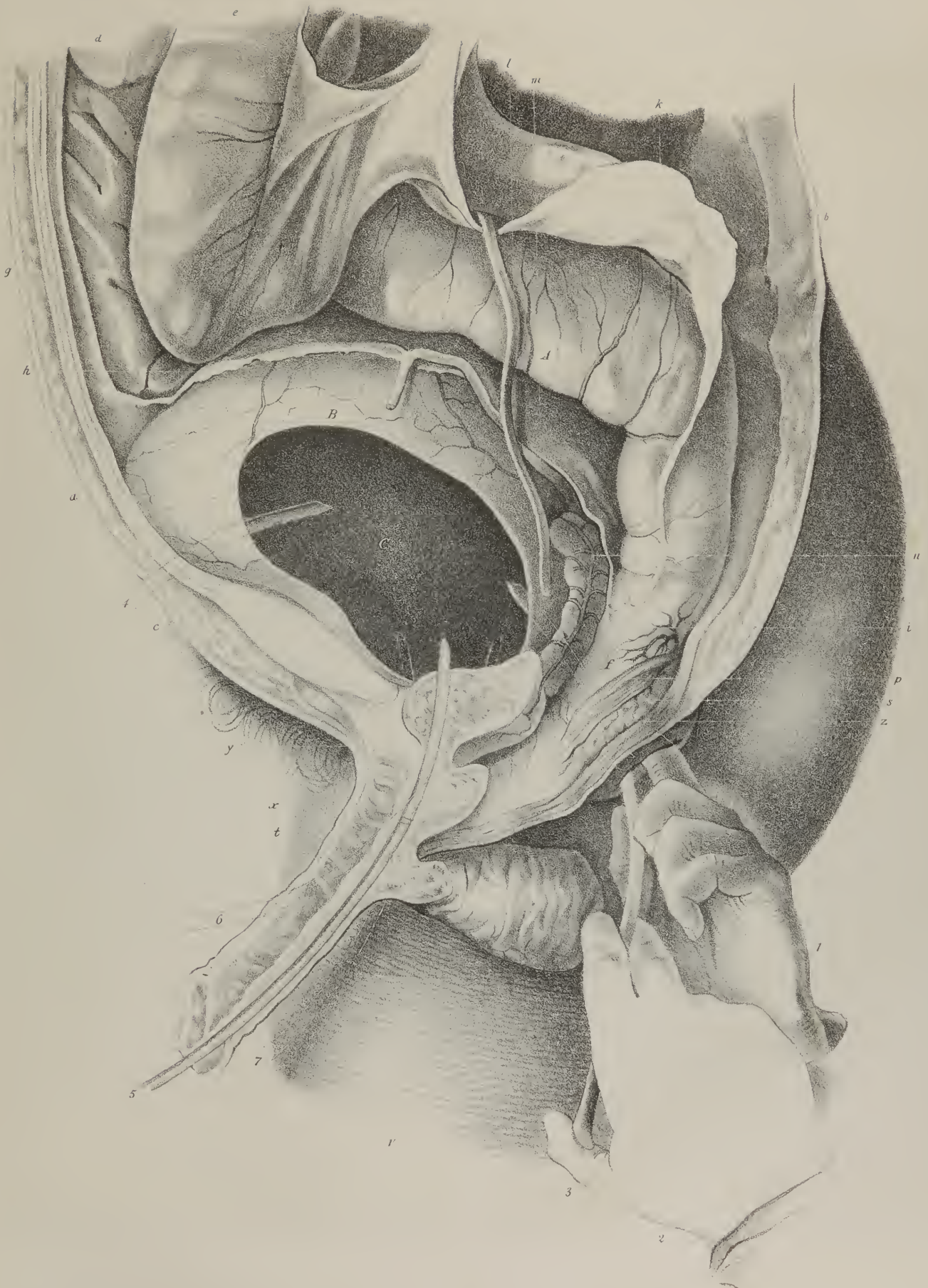
(A). Rectum. (B). Bladder. (C). Cavity of the bladder. (D). Perineum.

a. Line of section of the abdominal wall. *b.* Section of the posterior wall. *c.* Symphysis pubis. *d.* Small intestine above the bladder. *e.* Sigmoid flexure of the colon. *f.* Pouch of the rectum. *g.* Line of section of the peritoneum, which is seen reflected round the posterior face of the bladder down to the bottom of the pouch (*i*), which it forms between the bladder and rectum. *k.* Parietal peritoneum, as it passes up to line the iliac fossa. *l.* Ureter. *m.* Vas deferens, running down on the inner side of the vesicula seminalis (*n*). *p.* Internal sphincter muscle of the rectum. *s.* Levator ani, divided near its insertion into the rectum, immediately below which is seen the external or anal sphincter. *t.* Penis, split through the median line. *y.* Membranous portion of the urethra. *z.* Prostate, divided in the middle line.

1, 2, 3. *Puncture of the bladder from the rectum.*—1. Left hand of the surgeon, the fore finger introduced through the anus and seen outlined with the point behind the prostate. 2. Right hand of the surgeon, holding the trocar, which has been passed up in front of the left fore finger; the point of the stilet is projected into the bladder with the thumb of the right hand (3).

4. *Puncture of the bladder above the pubis.*—The position of the trocar is outlined above the pubis; the projecting point of the stilet and the end of the canula are seen in the cavity of the bladder.

5, 6, 7. *Puncture from the urethral passage.*—5. Proper position of the trocar or *sonde a dart*, in making the puncture in the normal direction of the passage. 6. Line of direction in which the puncture would be made through the lower part of the prostate. 7. Line of direction which would carry the trocar above the prostate.



direction at right angles with the axis of the abdomen. The trocar should be inserted to a depth between two and a half and four inches, according to the size and obesity of the patient. As soon as the resistance ceases and the point of the instrument is felt to penetrate the bladder, it should be turned somewhat more in the direction of the axis of the bladder to avoid the injury of the posterior wall of that organ. The stilet is now withdrawn, and the urine discharged through the canula, the patient facilitating its escape by inclining himself for that purpose upon one side. A compress is to be placed under the shield of the canula, and the instrument secured with tapes to the horizontal part of a T bandage. The mouth of the canula is to be plugged, the plug being withdrawn at intervals of two or three hours to allow the urine to escape and prevent the over-distension of the bladder. In this case it would not be safe, as in the puncture of the rectum, to substitute a flexible catheter for the canula under the space of a week, as the former instrument would lie too loose in the wound to obviate the risk of infiltration of urine on the outer side of the bladder, which, when it takes place, gives rise to sloughing. At the end of a week, provided the catheter cannot earlier be passed by the urethra, this change may be made—the flexible catheter, which should be well secured without, being found to cause less irritation in the bladder than the silver canula—as by this time the track of the instrument will be surrounded by a deposit of lymph, so as to prevent infiltration. At the end of eight or ten days the track of the wound is rendered completely fistulous, and some surgeons have advised the complete removal of the canula at this period, allowing the urine to escape simply by the fistulous passage. But this course is not advisable, as it would still be attended with risk of inflammation and abscess of the cellular tissue of the pelvis, unless the urethral passage has been rendered pervious, and it is desirable to allow the artificial outlet to close.

Puncture from the perineum.—This was practised by Dionis and some of the older surgeons, by entering a straight trocar at the middle of a line, drawn from the tuberosity of the ischium to a point in the raphe of the perineum two lines in front of the anus. The point of the trocar is to be pushed on in such a direction as to meet the axis of the trunk at the distance of two or three inches from the place of entry. The operation has, however, been abandoned in consequence of the risk which it involves of wounding one of the vesiculæ seminales, one of the deferent ducts, or even of missing altogether the bladder, the position of the fundus of which varies considerably in different individuals, and in various states of disease. If practised at all, it should be preceded by an incision of the soft parts as in the lateral operation for stone, or by the opening in the middle line recommended in cases of retention from stricture.

In females it is seldom necessary to puncture the bladder. But should it be, as has sometimes been the case in cancerous affections involving the urethra, the operation is to be practised above the pubis, or through the anterior wall of the vagina.

OPERATION FOR STONE.

LITHOTOMY IN THE MALE.

There are many processes for the removal of calculi by a cutting operation, all of which may be arranged in three classes:—

1. By a cut through the region of the Perineum.
2. Through the partition between the Rectum and Bladder.
3. Through the Hypogastrium.

Operation through the Perineum.

Surgical anatomy of the perineum.—The inferior outlet of the pelvis is usually considered as divided into two triangles by an imaginary line, extended between the two ischiatic tuberosities, and crossing just in front of the margin of the anus. Each of these triangles is nearly equilateral, the sides being about three inches in length. The anterior triangle circumscribes the region of the perineum—the posterior, that of the anus and rectum. The lateral margins of the perineal triangle are formed by the rami of the ischium and pubis, and the apex presents to the symphysis of the pubic bones. But this region has depth as well as superficialities. Its *vertical* depth is, at the symphysis pubis, about an inch—between the extremity of the recto-vesical pouch of the peritoneum and the skin in front of the anus, about three inches in an adult ordinarily fat; making the perineum somewhat triangular when examined on the side of a vertical cut through the median line. When we turn off the skin and common superficial fascia from the surface of the perineum, and strip away also the peritoneum from the bottom of the cavity of the pelvis, we have the parts of the perineum requiring particular study, included within spaces formed by three proper perineal fasciæ—the inferior, the middle, and the superior—the last of which is formed by the pelvic aponeurosis. The *inferior perineal fascia*, (sometimes though improperly called superficial fascia of the perineum,) is found immediately below the skin and common superficial fascia. It is extended between the crus of the pubis, crus of the ischium, and ischiatic tuberosity of either side. It is prolonged anteriorly so as to be continuous with the cellular tissue of the scrotum and penis, and terminates posteriorly in a sort of crescent which spans the front surface of the lower end of the rectum, where it will be found on turning down a V shaped section of the fascia, (cut so that the apex of the A shall present to the scrotum,) to be continuous with the middle fascia of the perineum by being folded inwards and backwards round the posterior face of the transversalis perinei muscle. In the space between the inferior and the middle perineal fascia, are lodged several parts for consideration. 1. We have on either side, the crura of the penis, covered by the erector penis muscles; in the middle line the corpus spongiosum and bulb of the urethra, which are completely hid by the accelerator urinæ, muscles, and extended backwards from the junction of the crura with the body of the penis, to the perineal centre just in front of the anus, where several muscles of the perineum meet. Between the erector penis muscle of either side and the accelerator urinæ there is necessarily a triangular space, bounded on its upper surface by the middle perineal fascia or triangular ligament of the urethra, the apex of which is near the junction of the crus with the body of the penis. It is in this triangular space on the left side, that the cut is made in the lateral section for stone. The transversalis perinei muscle is extended across, just in front of the line which divides the perineal from the anal region, between the tuberosity of the ischium and the perineal centre, accompanied frequently by the artery of the same name, both of which are necessarily divided in the lateral cut for stone when this is ex-

tended well back between the centre of the anus and the ischiatic protuberance.

If we clear away the muscles, leaving only the bulb and spongy portion of the urethra, we have a full view of the front surface of the *triangular ligament of the urethra* or *middle fascia of the perineum*. This consists of a membrane stretched between the crura of the ischium and pubis, so as to serve as a partition across the perineum extending for an inch and a half below the symphysis of the pubis. At the distance of an inch below the symphysis, and half an inch above its lower border, it is pierced by a small opening through which passes the mucous canal of the urethra. At its lower border it is united with the posterior edge of the inferior perineal fascia just described, and both together are reflected upwards and backwards between the prostate gland and rectum. On cutting through this lower surface of the triangular ligament, we find it a double fascia, the upper layer of which is at the symphysis nearly in contact with the lower, from which it diverges as it passes backwards and slightly upwards over the membranous part of the urethra to the top surface of the prostate gland and the neck of the bladder. At this point the upper layer is continuous with the layer of pelvic fascia, which lines the superior surface of the levator ani, forms the anterior ligament of the bladder, and dips down to the front part of the neck of this organ. The lower layer of the middle perineal or triangular ligament which is reflected back between the prostate and the rectum, is continuous upon the sides with that portion of the pelvic fascia lining the inner surface of the levator ani muscle. An irregular triangular interval is thus left between the two layers of the middle perineal fascia. In this interval are lodged, 1st, the membranous part of the urethra, which is about five-eighths of an inch long, surrounded by its two sphincter muscles—the muscles of Wilson and Guthrie; 2d, the whole substance of the prostate gland, through which the canal of the urethra is continued behind the membranous portion backwards and upwards into the bladder; 3d, the internal pudic artery, which runs up close to the margin of the bones, and sends an artery across to enter the bulb; and, 4th, the glands of Cowper, which, though unimportant in a surgical point of view, will be found on the upper surface of the lower layer of the ligament. If the prostate gland be dissected up from the surface of the rectum, it will be found separated from it by the reflection of this lower layer, which runs upwards to the bladder, forming a part of the recto-vesical fascia covering the bottom and sides of the prostate, and is continuous with that layer of the superior perineal or pelvic fascia, reflected off from the surface of the levator ani muscles to the upper part of the prostate and the bladder.* By this arrangement the prostate gland gets a complete capsular investment, and is left out of the cavity of the pelvis by being kept below the superior perineal or pelvic fascia. At the angles where these two layers meet, is lodged the prostatic venous plexus, the veins of which communicate directly through large orifices in the superior perineal or pelvic aponeurosis, with the vesical plexus lodged between the peritonæum and the side and lower fundus of the bladder. If this lower layer, as it ascends on the side of the

* Vid. Quain's Anatomy or Pancoast's Wister, edit. of 1843. This upper layer may, according to the will of the surgeon, be considered as belonging to the middle or upper perineal fascia.

prostate, is cut high up, as is commonly the case in the lateral operation for stone, no particular danger arises, provided the superior fascia which covers the base of the prostate is left uninjured. It necessarily involves, however, a lesion of the prostatic veins, and as these are large, especially in old men who have long suffered from disease of the parts, and are unprovided with valves, they become, from the anastomosis with the vesical plexus, a frequent source of venous hemorrhage.

On dissecting the prostate gland loose from the rectum and pushing it upwards, it will be found lodged in the angular fossa formed by the anterior edges of the two levator ani muscles. If the dissection is continued farther backwards, it will be seen that the inferior layer of the prostate is continued from the base of that organ, as just described, where the two fascia meet over the vesiculæ seminales, (which are found nearly at the centre of its back part,) and diverge upwards and backwards on the bas fond of the bladder. As the levator ani of either side bends inwards from the top of the perineal region, so as to embrace the lower extremity of the rectum and be inserted in the middle line, a triangular space is left between the muscle of either side and the ischium, which has been denominated by Velpeau the ischio-rectal fossa. This is found partly in the perineal and partly in the anal region, and has its apex extended upwards to the point where the internal obturator muscle is in close apposition with the origin of the levator ani from the pelvic fascia. This fossa is lined on its surface with a thin fascia, and is filled with fat in which exist a great number of veins. Some arteries are also observed in it—the inferior hemorrhoidal, which cross it as they go transversely from the internal pudic to the rectum—and the superficial perineal, which from the same arterial trunk is sent off parallel at first with the ischium underneath the common integuments, to reach the raphé of the scrotum and supply the dartos muscle, sending a branch up in the septum scroti. The trunk of the internal pudic, as before observed, is continued up between the two layers of the middle fascia or triangular ligament, sending off a transverse vessel to the bulb, a branch which enters the cavernous structure at the crust of the penis, and terminates by becoming the dorsal artery of the penis.

In some rare instances of anomaly, the dorsal artery is not the terminal branch of the pudic, but is sent off from the trunk of the latter lower down in the perineum, so as to cross on the lower surface of the prostate, and be liable to be cut in the lateral operation for stone.

The object to be kept in view in the operation by the perineum, is to open a free passage to the stone without dividing any important arteries or wounding the rectum. The posterior part of the bulb is found usually eight or ten lines distant from the anus, and sometimes much less, especially in old men. There are four arteries more or less liable to be wounded—the *trunk of the internal pudic*, the *superficial artery of the perineum*, the *transverse artery*, and the *artery of the bulb*.* The first is closely attached by fascia to the crura of the ischium and pubis, and is not liable to be injured unless the cutting instrument is brought nearly in contact with the bone. The superficial artery of the perineum runs superficially in front and to the inner side of the erector penis muscle; the *transverse* artery crosses the perineum with the trans-

* The last two frequently come off from the pudic by a common trunk.

versalis muscle, and in many instances sends a branch obliquely forwards from near its place of origin to the bulb. From this arrangement of the vessels, the operation, if the external incision is begun *behind the bulb*, does not necessarily involve any of these vessels except the transverse branch, which is usually too insignificant in size to occasion any trouble, and is so superficial that it can if necessary be readily tied. Many surgeons, however, begin the incision higher up, dividing usually the bulb and the artery which supplies it, and though the larger external wound which they by this means get gives ready access to the bladder, they are sometimes inconvenienced by bleeding from the bulb, which it is occasionally found difficult, especially in old men, to arrest, save by the ligature of the trunk of the internal pudic, as it ascends along the rami of the ischium and pubis.

In cases of wound of the dorsal artery of the penis, where the vessel has the anomalous origin above described, the trunk of the internal pudic may be tied under the ischium, provided pressure on this vessel is found to check the hemorrhage. But if the branch comes off from the artery before it reaches the perineum, and the hemorrhage cannot be arrested by tamponing the wound, the divided orifice of this vessel is to be tied, if possible, at the top of the incision—or, this failing, resort is to be had to the means of arresting the circulation in the trunk of the pudic on the back of the pelvis, described at page 73. If the external incision have the proper direction, and be not carried farther back than is directed in the text, the rectum, provided it has been previously well emptied of its contents, will not be liable to injury from the knife. If it be found greatly dilated, as is sometimes the case in old men, it may, as a measure of precaution at the time of making the external incision, be forced backwards by a finger introduced into the anus. In extending the incision from the bottom of the external wound to the neck of the bladder, the principal point of importance to be divided is the prostate gland, which necessarily involves a section of the membranous portion of the urethra, and the triangular ligament or middle perineal fascia. The prostate is sufficiently large to admit of a section which will allow of the extraction of a stone from an inch to an inch and a half in diameter, according to the manner in which the division is made. In calculating the extent of space to be gained by an incision of a particular width through the substance of the gland, the dimension of the prostatic portion of the urethra, which in the adult will be found rather more than the third of an inch in diameter, or an inch in circumference, is to be added to the extent of the cut in the prostate. Thus, if an incision of three-quarters to seven-eighths of an inch be made through one side of the prostate, which in the adult can be done with entire safety through either one of the lobes of the gland, we would have on separating it the inch and a half of its circumference to be added to that of the urethra, furnishing a space sufficiently large for the withdrawal of a stone three-quarters of an inch or even an inch in diameter. If on account of the size of the stone this space should be found insufficient, it might be increased by a transverse or oblique incision of the opposite lobe of the gland, as in the process of Dupuytren, or a quadruple incision may be made by adding to the two lateral incisions two vertical cuts in the middle line—one upon the upper and one upon the lower segment of the gland, as recommended by M. Vidal. When the prostate is sound, its tissue

will be found to stretch by the application of moderate force in the withdrawal of the stone, and if it be found diseased, it will usually at the same time be enlarged so as to admit of an incision more extensive than that just referred to. Stones are, nevertheless, occasionally met with too large to be extracted through any opening that can be made through the prostate, or even to pass between the limits of the pubic arch—rendering it necessary to break them in the bladder and remove them piecemeal, or extract them by the high operation.

There are three modes of operation through the perineum—the *lateral*, the *bilateral*, and the *median*, so named from the respective portions of the prostate gland through which the incision is made.

LATERAL OPERATION.

There are several modes of effecting the division of the prostate gland in the lateral operation, in all of which the section is made on the left side of the perineum in consequence of the greater facility this affords in the use of the right hand:—1st. Those in which the cut is made from before backwards, with a stout scalpel; 2, with a gorget; and a third, in which the prostate is divided from without inwards, by the retraction of the *lithotome caché*—the primary division of the external parts, and the position in which the patient is placed, being the same in all.

The division of the prostate with the knife.—This is the favourite method of operation with most British surgeons of the present day, and with many of those of this country. It is well described as follows, in the recent work of Professor Syme. “The instruments required are—1. A grooved staff to guide the knife in cutting into the bladder. It ought to be of the largest size that the urethra will readily admit, which is usually No. 11 of the bougie scale,* and the groove should be very wide and deep, neither on the side nor convex surface, but in the intermediate space, so as to correspond with the direction in which the incision is carried. Mr. Aston Key has recommended a straight staff,—which certainly has the advantage of conveying the knife more directly than a curved one, but is liable to the objection of occupying the operator’s left hand, while the section is made, instead of leaving it at liberty to press aside the rectum, and ascertain when the incision has been carried far enough. In children, where the prostate is easily divided, and where, from the necessarily small size of the instrument that is introduced, the difficulty attending a curved direction of the groove is greatest, the straight staff may be preferable. 2. A knife, which, including both the handle and blade, should be between seven and eight inches in length. The blade ought to have its cutting part at least two inches long, not very broad, and sharp enough at the point to permit its being pushed through the skin and other parts. 3. Forceps for extracting the stone, of two or three different sizes, of which the blades should be broad, moderately hollowed, and destitute of projecting teeth, which are apt to break the calculus. 4. A scoop to remove the fragments or gravel; and, 5. A flexible tube, about six inches long, and half an inch wide, to convey away the urine after the operation, and prevent its infiltration into the cellular substance.

* “Equal to No. 14 of the scale generally used in London.” In the operation with the gorget or the lithotome, the groove should be exactly on the convex surface.

"When the operation is to be performed, the patient should have his bowels freely evacuated by a laxative administered the day before. He should be placed reclining on a table about two feet and a half high, covered with a folded blanket, and under his head a pillow or two may be laid, but nothing to raise the shoulders. He is then to seize the soles of his feet, one in each hand, which should rest on the fibular or outer edge, and by means of a strong tape or bandage have the limbs secured in this position, after which they are to be confided to two assistants, one standing on each side of the table. The staff having been introduced, is now to be committed to a third assistant, who holds it up in one hand, and the scrotum in the other. The surgeon then seats himself on a chair, shaves off the hair from the perineum, feels the different parts that determine the place of his incision, and resting the fingers of his left hand on the skin so as to prevent any displacement of it, pushes his knife directly inwards at the anterior point of incision to the depth of the perineal muscles. He cuts in the direction above mentioned, making an incision about three inches long in the adult, extending from the raphé of the perineum to a point midway between the anus and the tuberosity of the ischium, so as to divide the skin, fat, superficial fascia, and transverse muscle, gradually diminishing the depth of his incision until it reaches its posterior termination; then introducing the fore finger

of the left hand into the centre of the wound, to serve as a guide for the knife and protection to the rectum, he cuts from this point upwards and downwards so as to divide the anterior part of the *levator ani*, and expose the membranous portion of the urethra, into which he makes an opening, and then, keeping the knife in the groove, while he satisfies himself, by taking the staff in his left hand, that it is held properly in the mesial plane close up against the pubis, he gives it again to the assistant, and pushes the knife steadily into the bladder, and fairly through the prostate; at the same time, with his left hand, holding down the rectum, and feeling what way is made with the knife. He then introduces his finger into the bladder, desires the staff to be withdrawn, and conducts in the forceps. He searches for the stone with the blades closed, and, having found it, opens them very wide, depresses, and then closes them. By gently relaxing his hold, and renewing it, he shifts the position of the calculus, if unfavourable for extraction, and, with the assistance of his left fore finger, proceeds to draw out the stone, not directly, but by a motion in alternate directions, so as to dilate the margin of the wound without tearing. Forceful efforts ought never to be used in doing this; and it is much better to introduce the knife again, if the opening proves too small. After one stone has been removed, the bladder ought to be searched for more, with a sound intro-

PLATE LXVI.—LITHOTOMY. LATERAL OPERATION.

Fig. 1.—*External incision*.—An assistant steadies the staff by grasping the end of it with the right hand, while he sustains the scrotum with the other (*a*). The external incision, as directed by the French surgeons, has been made of little extent, commencing in front of the anus and *just behind the bulb*. At the period of the operation shown, the surgeon has introduced the fore finger of his left hand (*b*) so as to sink the nail into the groove of the staff, to serve as a director to the point of the bistoury (*c*), with which he opens the membranous part of the urethra.

Fig. 2.—*Division of the prostate with the simple lithotome caché*.—The parts are shown reduced only a third in size, and the integuments and perineal fascia, with a portion of the triangular ligament, cut away to give a better idea of the more important part of the operation.

(A). Union of the two accelerator urinæ muscles, which cover the bulb of the urethra in the median line of the perineum. (B). Anus, in front of which the anterior edge of the sphincter and the anterior margin of the levator ani muscles have been cut away. (C). Prostate gland, covered by the middle perineal fascia or triangular ligament of the urethra. (D). Incision made in the left lobe of the prostate by the withdrawal of the lithotome.

Fig. 3.—*Large external incision, made with the scalpel as directed by the greater number of British and American surgeons*.—The parts are of the same scale of dimensions as in fig. 2. The proportionate length of the cutaneous incision is purposely exaggerated, to give a clearer view of the deeper seated parts.

a. Section of the skin, ordinary superficial fascia, and proper superficial or inferior perineal fascia. *c*. Incision deepened at the posterior part through the mass of fat in the ischio-rectal fossa, in which are usually divided the transverse perineal muscle and the anterior fibres of the levator ani. *b*. Incision made with the scalpel into the membranous part of the urethra, so as to expose the groove in the staff into which the beak of Physick's gorget has been directed on the finger nail. The incision into the membranous portion of the urethra has involved a part of the structure of the bulb—a result which at least very commonly takes place. *f*. The anus.

Fig. 4.—*Lateral view of the section of the prostate with the gorget, shown at the moment of its completion*.—

a. Section of the abdominal walls in the middle line in the subject from which the author has had the drawing taken. *b*. Symphysis pubis. *c*. Section by which the left crus of the penis has been removed. *d*. Prostate. *e*. Vesicula seminalis of the left side; above this a portion of the left side of the bladder has been removed in order to expose to view the stone; the staff, and the entering point of the gorget. *f*. Rectum. *g, g*. Line of reflection of the peritoneum. *h*. Staff, grasped with the left hand of the surgeon and depressed, while with his right hand (*k*) he pushes in the gorget so as to divide the membranous portion of the urethra (*i*) and the left lobe of the prostate.

Fig. 2

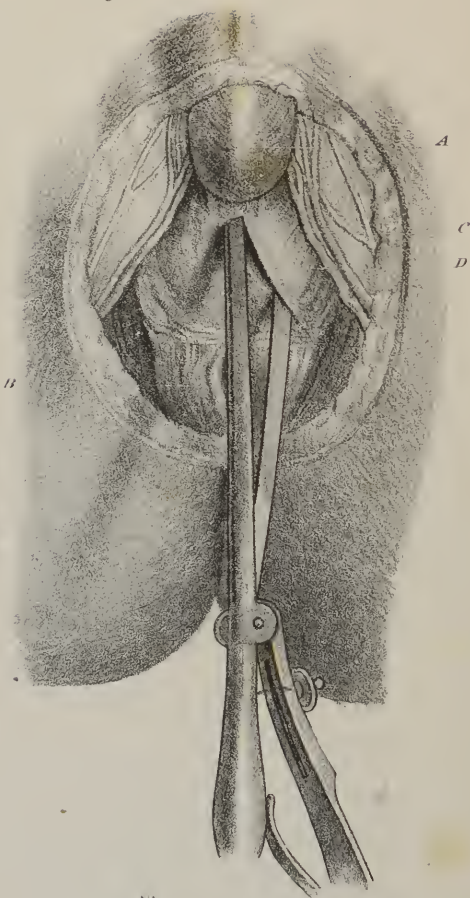


Fig. 1

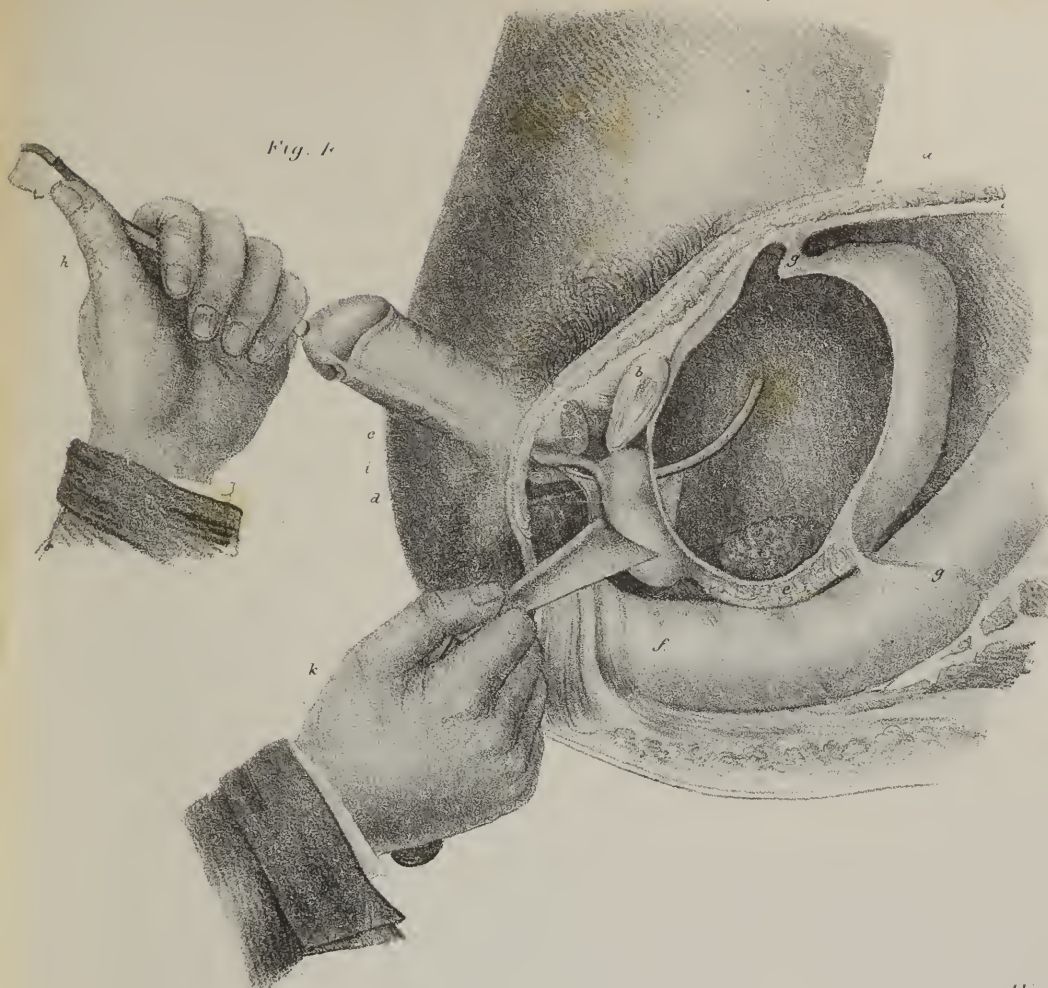


Fig. 1

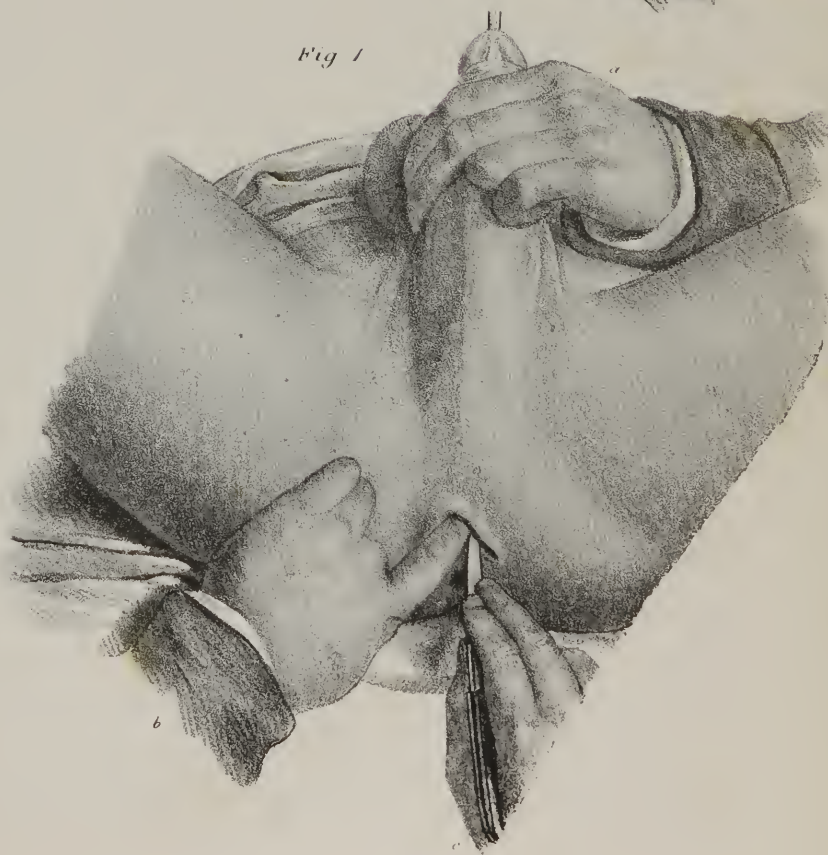
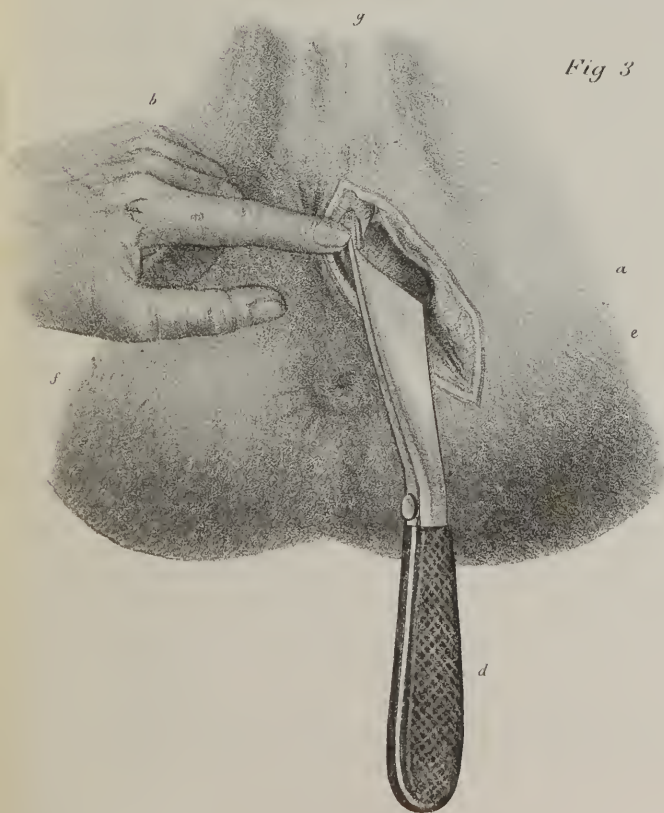


Fig. 3



duced through the wound; and if any are detected, they must be removed in the same way as the first. Should the calculus be broken, its fragments must be carefully extracted with the scoop, if small, or the forceps if large. The tube is then to be introduced, either alone, or, if there is much tendency to hemorrhage, with some folds of lint wrapped round its middle; after which the patient may be placed in bed, on his right side, with the limbs moderately bent.

"The after-treatment in cases that proceed favourably is extremely simple. Means must be employed to prevent the urine which distils through the tube from soaking the bed, by interposing a piece of oiled cloth between the breech, and a folded blanket laid under it, and applying tow or sponge at the orifice to imbibe the fluid. The diet, during the first three or four days, should be sparing, and of a farinaceous kind. Gentle laxatives, such as castor oil, are to be administered as occasion may require. The tube may be withdrawn at the end of two or three days. About the ninth day a little urine is generally observed to issue from the urethra; and when the natural passage thus begins to be resumed, the discharge by the wound very soon ceases, so that by the thirteenth or fifteenth day the whole is evacuated by the penis."

If the stone when withdrawn presents one or more smooth facets upon it, it is certain by this evidence of friction, that two or more calculi have existed in the bladder, and careful search must be again made in the bladder by introducing the fore finger through the wound. Sometimes, but fortunately very rarely, as it renders the case embarrassing to the surgeons, the stone will be found either encysted—enclosed in cyst or sac formed by a doubling of the two inner coats to more or less extent between the muscular fibres of the bladder, or adherent by bands to the lining mucous membrane. In either case the bladder is to be carefully sounded with the finger; if from the thickness of the perineum, the finger be found too short to reach, an assistant may make pressure downwards upon the hypogastrium, while the surgeon, if this should not suffice, introduces two fingers of the other hand into the rectum so as to elevate the base of the bladder. If the stone be encysted, and one end of it is found projecting into the cavity of the organ, the free portion may be grasped with the forceps, and some attempts made to dislodge it from its site. If this does not succeed, the edge of the mucous membrane girdling the stone, may be incised with a probe-pointed bistoury, and the stone farther loosened in its seat by acting on it with the finger nail. But if the stone be so completely enclosed that its end cannot be felt projecting in the bladder, all attempt at its removal should be abandoned as any operation at all in the case has been most unwisely undertaken. If the stone lays up in relief on the coats of the bladder, but is merely adherent, the adhesions if not strong may be ruptured by twists with the forceps; if too strong to be thus ruptured, they may be divided with a probe-pointed bistoury or a pair of blunt-pointed scissors. But it is the practice of the author, before operating for stone, to satisfy himself of its freedom in these respects, by passing the curved end of the sound between it and the bladder, by which means the adhesions, if they are not very firm, will be ruptured.

Division of the prostate with the gorget.—This instrument, as modified by the late Dr. Physick, in rendering the blade shifting so that it may be separately sharpened and made to bear the

keenest edge, has been very commonly used in this country for the division of the prostate. It has probably been employed in two-thirds of all the cutting operations for stone done in this city for the last thirty or forty years, and which, as shown by the statistical reports of the Pennsylvania Hospital, have been attended by as large an average of success as those by any other mode of operation. It is the favourite instrument of Professor Dudley, of the Transylvania University, who has operated a greater number of times than any other American surgeon, and with a success that has been unexampled.

By the sound, by examination through the rectum, and by the use of the lithotriptic instruments, we have the means of determining with very considerable precision, the size and character of a calculus previous to the operation; and as it has been shown in the brief account of the surgical anatomy of the perineum, that we can determine the requisite dimension of the wound necessary for its withdrawal, which in a large majority of cases may be restricted to one lobe of the prostate, the gorget, by choosing a blade of appropriate dimensions, furnishes to the surgeon a surer means of accomplishing at once a section of the necessary extent than any other instrument. The direction in which the blade of the instrument is affixed to the shaft, insures that the section of the gland shall be made obliquely downwards—the direction in which it may be most freely cut. As it slides along nearly at right angles with the various portions of the curve of the staff, it moreover cuts the substance of the gland somewhat concentric to the curve of its lower surface; this rather facilitates the extraction of the stone by rendering the cut portions more dilatable, and places the parts at the same time under the most favourable circumstances for reunion, and for the prevention of the sad consequences that sometimes ensue—incontinence of urine and urinary fistula. It has been objected to the gorget—that it makes the incision too mechanically and too blindly, it having no guide for its direction but the groove in the staff—that if it slide from the latter instrument it may plunge between the bladder and the rectum, and that the cutting edge of the gorget, even when it keeps the proper direction, may enter so far as to wound the posterior surface of the bladder. These objections, which might have been tenable against the imperfectly sharpened instrument of this description heretofore employed in Great Britain, are wholly inapplicable to the keenly-set gorget of Physick, which requires but a gentle effort for its introduction, and, in the hands of any one who understands the use of cutting instruments, cannot possibly either slip from the staff or wound the posterior wall of the bladder. In at least a hundred instances in which the author, after making the cut with the gorget on the dead body, has subsequently examined the parts by dissection, he has not noticed either of these results. The sensation of resistance overcome, the gush of urine from the bladder, and the contact of the gorget with the stone which is sometimes felt, are sufficiently indicative of the proper time for the arrest and retraction of the instrument. To obviate any possibility of injuring the posterior wall of the bladder, Dr. George P. Norris, of this city, as an additional measure of precaution, extends the thumb upon the upper face of the blade so as to limit the extent of its introduction.

Operation. (Pl. LXVI. figs. 3, 4.)—The difference between this operation and the preceding one consists merely in the substitution of the gorget for the knife, in the incision of the prostate

at the last stage of the process. As soon as the staff can be felt through the membranous portion of the urethra, the surgeon sinks the nail of the left index finger into the groove, directs the scalpel along the nail so as to open freely the membranous portion and bring the edge in contact with the staff. He then sinks the nail through the puncture last made till he feels it rub against the groove of the staff. Changing the knife for the gorget, he carries the beak of the latter along the nail into the groove at right angles with the curve, as shown at fig. 3, and slides it up and down till he is well assured from the peculiar grating sensation it gives, that it is fairly lodged in the groove. Now, taking the staff from the assistant, and grasping it firmly with the left hand as shown at fig. 4, he brings down the outer end in order to lift the prostate from the rectum, while the right hand acting in unison keeps the gorget firmly applied in the groove. Then, moving the beak a little to and fro to be assured that it is still in the groove, he carries the gorget—with the edge of the blade inclined downwards and outwards—onward with a uniform steady effort, till the instrument enters the bladder. The cessation of resistance and the gush of fluid from the bladder, show that the prostate is divided. As the gorget moves on towards the bladder, the handle is to descend in front of the anus, so as to keep the beak in its nearly perpendicular direction upon the groove, and prevent the possibility of its slipping. As the gorget ascends the curved portion of the groove, I find a still farther and consentaneous lowering of the outer end of the staff with the left hand to render the section more neat and easy. The surgeon now withdraws the gorget, passes the left fore finger up the wound into the bladder, and removes the staff which can no longer be of any service, with the right hand. The introduction of the forceps and the extraction of the stone are practised precisely as in the preceding process. In case the size of the stone

should prove too great for the orifice in the prostate, this is to be enlarged by prolonging downwards the incision of the gland with a curved probe-pointed bistoury. If sufficient room cannot in this way be gained without cutting beyond the limits of the prostate, it will be necessary to break the stone in the bladder with a pair of strong screw forceps, and remove the larger fragments with the ordinary forceps, the lever, or a curette, and wash out the smaller through the wound by the injection of a mucilaginous fluid.

Lateral section with the single lithotome caché.—The peculiarity of this operation consists, as in the gorget operation, in the mode of dividing the prostate. The lithotome, with the knife concealed in the groove, is carried, with its concave surface upwards, from the wound made in the membranous portion of the urethra into the bladder. The surgeon now disengages the lithotome from the staff, and removes the latter from the urethra. He next, with the stalk of the lithotome, endeavours to determine the size of the stone, in order to judge if it will be necessary to increase the extent to which it is intended to open the blade, which should not, however, according to Boyer, even in cases of old men, exceed the numbers 9, 10, or 11, which are marked on the instrument. The surgeon now raises the point of the stalk so as to lift it from the bottom of the bladder and bring it under the arch of the pubis, and inclining it at the same time against the crus of the pubic bone, springs the blade by pressing on what is called its tail. He then turns the blade in the course of the external incision, and incises the neck of the bladder and the prostate by drawing the instrument out, opened, in a perfectly horizontal direction, as shown at Plate LXVI. fig. 2. As soon as the resistance from the prostate ceases, the blade may be allowed to fall a little back into its groove, for fear of wounding the rectum, or dividing, if brought out at its full expansion, the two branches or the trunk of the in-

PLATE LXVII.—LITHOTOMY.

BILATERAL OPERATION. VESICO-RECTAL OPERATION.

Fig. 1.—Mode of withdrawing the stone by the forceps, after either of the operations shown in the preceding plate.—*a.* Hand of an assistant sustaining the scrotum. *b, c.* Hands of the surgeon, as applied at the period of the operation shown, when the stone is on the point of being withdrawn through the external wound.

Fig. 2.—Section of the prostate with the double lithotome caché. (*Process of Dupuytren.*)—The parts have been exposed by dissection nearly as in Plate LXVI. fig. 2.

(A). Bulb of the urethra, beneath which is seen part of the remains of the triangular ligament. (B). Anus. (C). Internal pudic artery and vein. (D). Double section of the prostate, made by the withdrawal of the double lithotome with the right hand of the surgeon (*a*). This instrument is slightly modified from that of Dupuytren, so as to render the section of each half of the prostate more sloping downwards, in order to diminish the risk of wounding the pudic vessels.

Fig. 3.—Recto-vesical section. (*Processes of Vacca Berlinghieri and Sanson.*)—An assistant holds the staff vertically in the left hand (*a*), and supports the scrotum with the other. The surgeon divides first the integuments by an incision from the anterior angle of the anus made from below upwards. He then plunges the point of the bistoury into the groove of the staff, and, running the knife upwards and backwards along the groove, divides the prostate in the middle line, as shown in the succeeding figure.

Fig. 4.—Vertical section of the prostate.—(A). Bulb of the urethra. (B). Orifice of the anus. (C). Internal pudic vessels. (D). Vertical incision of the prostate, exposing the groove in the staff (*d*). (E). Bistoury, employed in the right hand of the surgeon, with which, at the period of operation shown, the sphincter and the anterior wall of the rectum to the extent of eight lines have been divided, and the bistoury, which has been carried along the groove into the bladder, is about to complete the section of the prostate.

Fig. 2.

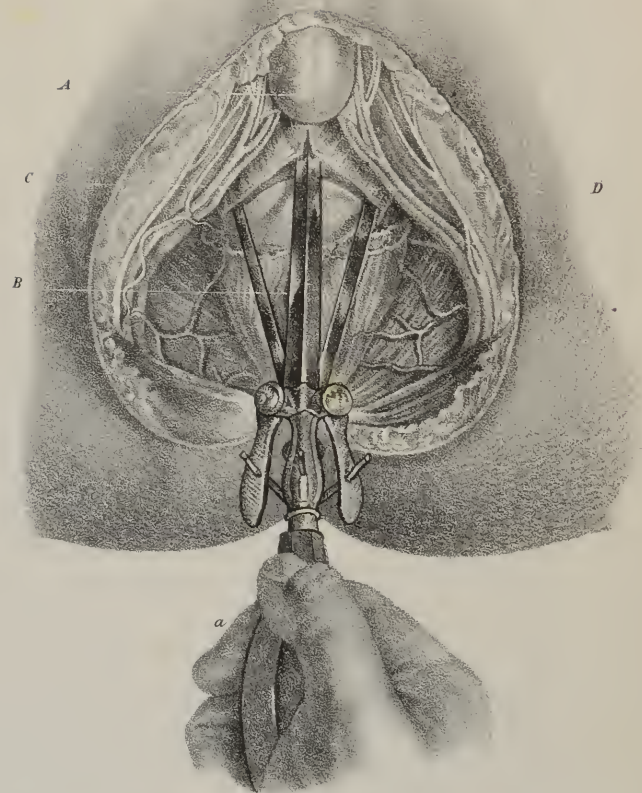


Fig. 3.

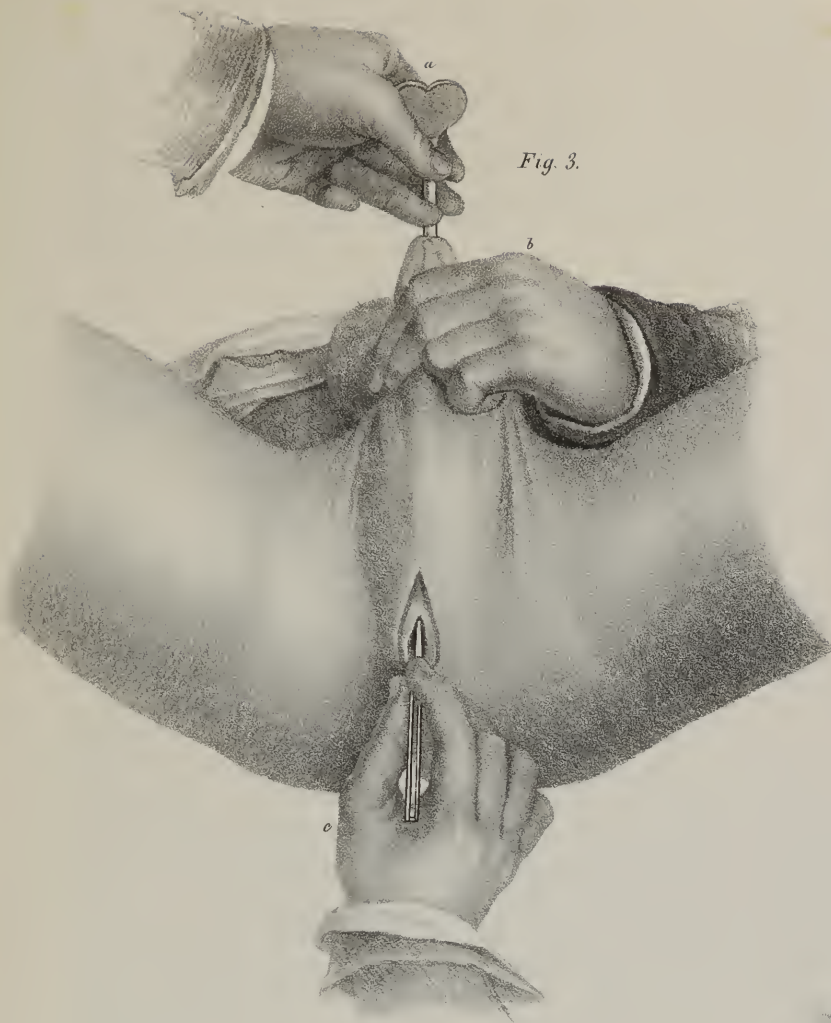


Fig. 1.

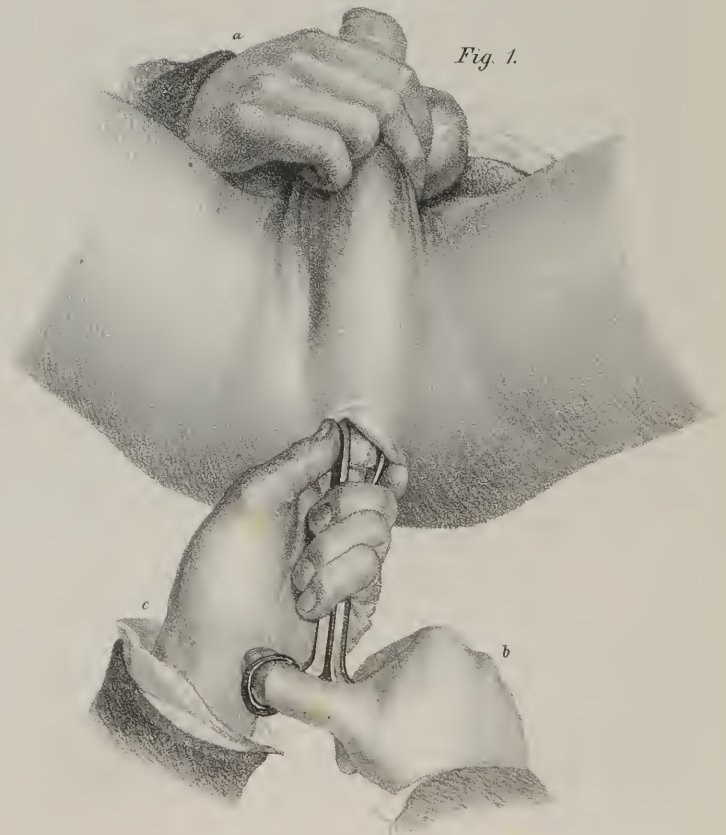
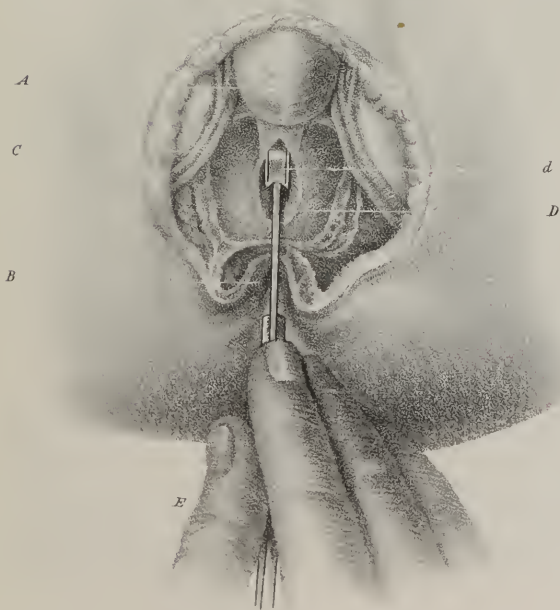


Fig. 4.



ternal pudic artery. Except in a well-practised hand, the incision of the prostate with this instrument is accompanied with considerable risk of wounding the bas fond of the bladder, or the vas deferens, as from the varying depth of the perineum in different subjects, the surgeon cannot positively tell when he springs the blade the exact extent of the instrument (which should not exceed an inch) projecting into the bladder.*

BILATERAL OPERATION.

The principal peculiarity of this operation consists in making a lateral section on either side of the prostate, so as to gain the greatest opening possible through the gland, prevent the contusion and laceration of that organ in the extraction of the stone with the forceps, reach the bladder by the nearest rout, and diminish the risk of wounding the internal pudic artery. This operation, the first idea of which is found in Celsus, was brought into favour by Dupuytren, and is believed by many to offer peculiar advantages, especially in the removal of calculi of large size.

Process of Dupuytren. (Pl. LXVII. fig. 2.)—The patient is to be placed precisely as in the ordinary lateral operation. The sound is passed in like manner into the bladder, and should be held exactly in the median line. The surgeon makes a semilunar incision, convex in front, which crosses three-quarters of an inch in front of the anus, and extends from the middle point between the anus, and the ischium of either side. The membranous portion of the urethra is then opened as in the lateral operation, and the double-bladed lithotome, shown in the drawing, entered with its concave surface upwards, the blades being concealed in the grooves. The staff is then withdrawn, and the lithotome turned so as to present its concave face toward the rectum. The blades are now sprung, and the instrument is withdrawn with the handle inclined a little downwards, making, as shown in the drawing, a double section of the prostate gland. The finger is then passed into the wound, and the forceps introduced to seize the stone.

In case the stone is found too large to be withdrawn through the space thus gained, a probe-pointed bistoury may be introduced to extend the cuts further upon the sides, or, as advised by *Vidal de Cassis*, for the purpose of incising the vesical surface of the prostate, first upwards and then downwards from the urethra, so as to convert the *bilateral* into a *quadrilateral* section of the prostate, which not only serves to enlarge the space, but renders the structure of the gland more distensible and yielding.

Objection has with some reason been made to this process of Dupuytren. Besides the increased risk of cutting the walls of the bladder by arming the lithotome with a second blade, the dimensions of the opening made cannot positively be determined beforehand, since it is difficult to construct the blades so that they will not spring inwards towards the stalk when the structure of

the prostate is found unusually dense and resisting. To obviate this difficulty, Dr. A. H. Stevens, of New York, employs a double-bladed gorget, (*prostatic bisector*,) and makes with more precision a double section of the prostate from without inwards, as in the ordinary mode of using the gorget.

Dr. A. C. Post, of New York, has devised an instrument which makes an incision of the two sides of the prostate, from without inwards, which may be considered a decided improvement on the bisector of Stevens. The two triangular blades are made slifting, and therefore susceptible of being keenly set; they are attached to a hollow canula through which runs a mandrin, terminated by an oblong probe head, which is to be carried along the groove of the staff to the posterior part of the bladder. When the mandrin has entered the bladder, the staff may be withdrawn. The canulated bisector is now carried up over the mandrin and must necessarily keep the course of the canal, and the probe-point over which it cannot slide will prevent its wounding the posterior wall of the bladder. In using this instrument, I have found the triangular heel of the blades liable to hitch on their withdrawal against the fibrous tissue on the front of the prostate, an objection, however, which might be readily remedied by altering the angle.

Professor Warren, of Boston, has judiciously modified the process of Dupuytren in the following manner. The staff introduced into the bladder should be so held in the middle line as to press the bulb and prostate downwards, and render them more accessible in the early steps of the operation. A crescentic incision is then made, and the membranous portion of the urethra opened as in the process of Dupuytren. Into the groove in the staff a straight probe-pointed bistoury is passed. The assistant next by acting with the handle of the staff, raises the prostate in the direction of the symphysis pubis. The bistoury, with its edge looking obliquely downwards and to the left, is now to be carried along the groove of the staff into the bladder, the surgeon following it with the fore finger of the left hand applied upon its back. If the prostate is not as freely divided on its vesical as its outer face, (as I have commonly found to be the case in repeating this process on the dead body,) the bistoury is to be pressed with the finger resting on its back, and the incision enlarged as it is withdrawn. We have now an incision through the prostate as in the common lateral operation. If the stone is ascertained to be of small size the opening already made will suffice for its removal with the forceps. But if the stone be of large dimensions, the bistoury, before it is withdrawn from the wound, is to be carried with its back foremost over the finger, and made in a similar manner to divide the right half of the prostate. We have now a bilateral incision of the prostate, as in the operation of Dupuytren, made by a process which is more simple, and in all its stages under the control of the operator.

RECTO-VESICAL OR MEDIAN OPERATION.

In this method the surgeon divides the sphincter ani, a small portion of the lower end of the rectum, the cellular triangular space between the anus and the membranous portion of the urethra, and the inferior portion of the prostate gland. The operation is attended with but little risk of hemorrhage, and has, in the instances in which it has been practised, been attended with

* Professor N. R. Smith, of the University of Maryland, has devised an instrument by means of which the point of a bistoury can be thrust at once into the groove of the staff behind the bulb, and then carried on into the bladder without making a previous external incision, the wound being enlarged obliquely downwards to the usual extent as the instrument is withdrawn. By this process, as asserted by this distinguished surgeon, a great improvement is made in regard to "the simplicity, safety, and celerity of the operation."—(Vide Med. and Surg. Memoirs, by Nathan Smith, M. D., with addenda by N. R. Smith, M. D., Professor of Surgery in the University of Maryland. Baltimore, 1831.)

perhaps not more than the ordinary ratio of deaths. But from its liability to cause the obliteration of the excretory ducts of the testicle, and leave a fistulous communication between the rectum and bladder, it has been received with but little favour.

Process of Sanson and Vacca Berlinghieri. (Pl. LXVII. figs. 3, 4.)—The patient is to be placed, and a staff introduced into the bladder, as in the lateral operation. The surgeon then introduces his left fore finger into the rectum with the palmar surface forwards. Upon this he glides flatwise the ordinary straight sharp-pointed bistoury, and, at the distance of three-quarters of an inch from the margin of the anus, punctures the anterior wall of the rectum in the median line. The handle of the knife is now to be raised, and the blade, with its edge towards the symphysis pubis, is made as it is withdrawn to divide exactly in the middle line, the sphincter, the portion of the rectum in front of it, and the triangular perineal space between the anus and the membranous part of the urethra. The membranous portion of the urethra is next opened with the knife over the groove of the staff, and a probe-pointed bistoury passed into the bladder along the groove. The surgeon then depresses the handle of the bistoury and divides the prostate backwards and downwards in the median line, using the precaution not to cut beyond the circumference of the gland, or to extend further the incision in the rectum. Through the opening thus made the forceps may be passed into the bladder and the stone withdrawn.

Various modifications of the recto-vesical operation have been devised, but as they are now considered obsolete, it will be unnecessary to describe them.

SUPER-PUBIC, HYPOGASTRIC, OR HIGH OPERATION.

This is an ancient method, which is designated by the name of Franco, its inventor, and was frequently practised by Frere Come. It consists in making an opening above the symphysis

pubis, so as to reach the bladder when distended with fluid, without wounding the peritoneum. It is alike practicable upon the male and female. It is repudiated as a general method by nearly every surgeon of reputation and experience, though it is still practised as such by Souberbielle of Paris, and it is said with the ordinary average of success. The only peculiar advantages which it offers is a greater facility in the detachment of encysted or adherent calculi, and the practicability of removing such as are found of a size too great to be extracted safely by an incision through the perineum.

Before undertaking the operation, the surgeon should moderately distend the bladder by the injection of water, (or air as has been recently proposed by M. Baudens,) so as to raise its top to the distance of several inches above the symphysis pubis. It should be remembered, that it is only when distended that the bladder projects above the top of the pubis, or presses the peritoneum away from the lower extremity of the linea alba so as to make any deep incision in this region safe. If the bladder be found undilatable, so as to be incapable of retaining more than one or two ounces of fluid, as I have several times observed it in cases of stone, an indefeasible objection is presented to the high operation, whatever may be the size of the calculus.

Usual process. (Pl. LXX. figs. 1, 2, 3.)—The patient is to be placed as in the ordinary operation for hernia, but with the pelvis a little more elevated. The surgeon stands on the left of the patient, and makes from the symphysis pubis, in the direction of the umbilicus, an incision which in the adult should be three inches long. As soon as the linea alba is bared, it is to be opened by a short incision near the pubis. Into this opening the left fore finger is introduced, and the incision prolonged upwards with a probe-pointed bistoury. The fluctuation of the distended bladder may now be felt from the bottom of the wound. But to render its position more manifest, a curved sound introduced from the urethra may be pushed upwards, so as to project its anterior

PLATE LXVIII.—LITHOTRIPSY.

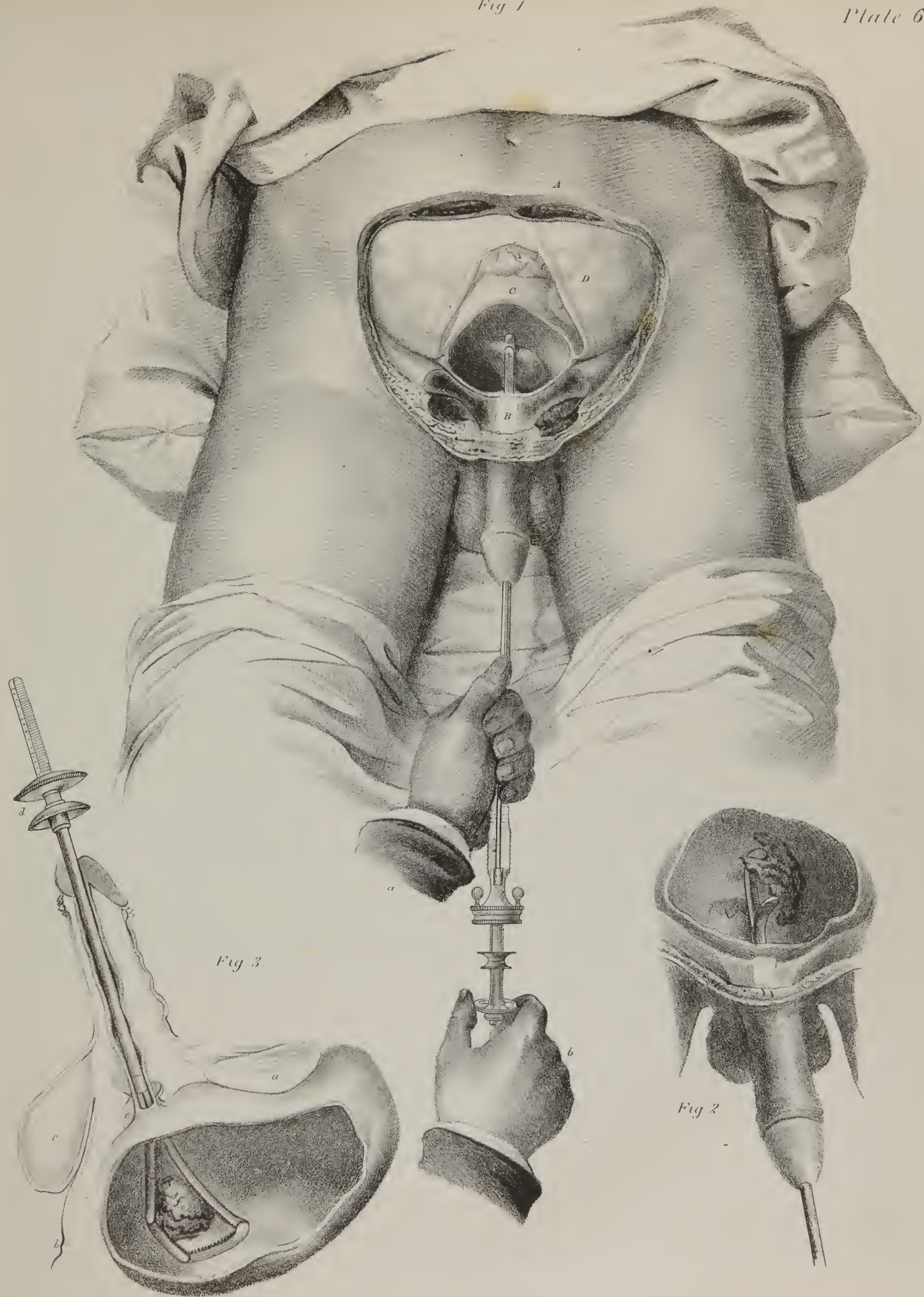
The operation is represented on the dead body, and a portion of the bladder removed to exhibit the mode of action of the instrument. The subject is placed on the back, the thighs separated and the pelvis elevated with a pillow. The anterior wall of the hypogastrium has been removed down to the root of the penis, and the pubic bones detached with the saw from the border of the psoas muscle of either side nearly down to the arch of the pubis, so as to expose the anterior face of the bladder.

(B). The lower portion of the interosseous substance, uniting the portions of the pubic bones left. (C). The bladder, represented with its cavity distended, and the upper half of its walls removed. (D). Peritoneal lining on the back part of the bladder, the middle portion of it cut away between the two umbilical ligaments.

Fig. 1.—Operation with the lithotriptor of Civiale.—The calculus has been seized between the blades of the instrument, raised from the bottom of the bladder; the instrument, which has been turned so as to present the ends of the blades upwards, is steadied with the left hand of the surgeon (a), while the screw is forced down with his right (b) to crush the stone.

Fig. 2.—Second step of the operation, in which one of the larger pieces left by the first application of the instrument is again grasped for the purpose of reducing it into smaller fragments. This constitutes the first method of using the instrument in cases where the disease consists of many small and separate calculi.

Fig. 3.—Application of the brise-pierre of Jacobson, shown in a side view of the pelvis.—a. Symphysis pubis. b, c. Section through the middle line of the scrotum and perineum. d. Button which is screwed down so as to crush the stone (f) seen enclosed in the loop of the instrument.



wall. With the left forefinger we now break away the cellular tissue, so as to expose the wall of the bladder; then, hooking this organ upwards with the finger so as to render its front surface tense, the surgeon passes the straight bistoury in a nearly vertical direction into its cavity with its edge towards the symphysis, as shown in fig. 2, and prolongs the incision downwards towards the pubis. As soon as sufficient space is made with the bistoury for the finger, this is to be hooked into the bladder to prevent the collapse of its walls. With the forceps we may now search for the stone. It will be found, however, more convenient first to raise the stone up to the orifice with a curette or spoon, as seen in fig. 2; then giving the curette to an assistant to hold, the surgeon can readily remove the calculus with the forceps. The search for the stone will be facilitated by having one margin of the vesical incision drawn off by an assistant with a blunt hook, as shown in fig. 1.

In the other operations for stone above described, no dressings are to be applied, for fear of damming up the urine and causing its infiltration into the cellular tissue of the pelvis. But in this they are absolutely necessary, to prevent the urine escaping through the wound in the anterior wall of the bladder into the loose cellular structure behind the pubis. The proper dressing consists in the introduction of an elastic catheter by the wound, and covering the sides of the incision with a couple of graduated compresses, secured with a body bandage. It is nearly impossible, however, to avoid altogether the infiltration of urine, for the canula cannot be of sufficient size to fill up the wound of the bladder. There will therefore, even with the introduction of a sound at the same time through the urethra, be more or less risk of urinary infiltration behind the pubis. Many surgeons object to the use of any sound or canula at all, as it necessarily wounds and irritates the bladder. But it would be more prudent to employ one above the pubis and remove it at the end of the first or second day, as by this time the track would have become more or less fistulous, so as to diminish the risk of infiltration into the surrounding tissue. For the purpose of guarding more effectually against this accident, M. Vidal has recommended the making a previous incision down to the bladder, filling up the wound with charpie, and at the end of a week, when the wound has suppurred freely, and there is reason to believe that the cellular structure on its sides is blocked up by a deposit of lymph, proceed to the opening of the bladder and the extraction of the stone. This modification of M. Vidal, though little used, has not, however, proved of much value in practice.

LITHOTRITY.

The principles involved in this operation, of which some faint traces may be found in the ancient writers, consist in the mechanical reduction of the calculus into minute portions by a drilling or grinding process, with instruments introduced through the urethral passage, without resorting to any cutting operation. To Gruithuisen, who in 1813 demonstrated the facility with which straight instruments could be introduced by the urethra into the bladder, is due the honour of having made the first step towards the scientific establishment of this operation. The contrivance of this surgeon was, by the successive improvements made upon it by Amussat, Civiale, and Leroy, brought to a surprising degree of

mechanical perfection. In its improved state it consisted of a straight silver canula, through which slid another of steel divided at its anterior extremity into three branches, which expanded by their own elasticity when pushed beyond the outer tube. While thus expanded they were placed over the stone, upon which they firmly closed on being again retracted. This internal steel canula in its turn enclosed a steel rod terminating in a head of variable shape, but so constructed as to act destructively on the calculus when put into rotatory motion by the string of the drill bow.

The use of these straight instruments, distinguished by Velpeau as the rectilinear method, was found to be attended with great difficulty of manipulation, and, even in the hands of so experienced an operator as M. Civiale, (who first employed it successfully upon the living subject,) with such injury to the organs and risk of life, as to present little if any advantage over the cutting operation. When the stone was reduced by excavation to the form of a thin shell perforated at several points, another instrument, called the *brise-coque*, or shell breaker, shaped like a slightly curved sound, and having strong jaws at its extremity which could be made to separate and embrace the stone, was employed to crush it by the force of a screw or by the blow of a hammer, applied against its outer end. In the course of time it was found that the crushing instruments, as employed by Jacobson and Heurteloup,* were of themselves sufficient to effect the demolition of the stone; and as they were more easy of introduction, and more readily made to embrace the stone in consequence of their curved form, the lithotritic operation has been completely supplanted by the following, denominated the lithotriptic or crushing process.

LITHOTRIPSY.

An infinite number of most ingeniously contrived instruments have been devised for this operation. To a few of these only will it be necessary to refer. The author has found four or five of the different kinds, but of varying sizes, sufficient in every emergency for the performance of the operation. Three of these are exhibited in the drawing—the *brise-pierre* of Jacobson, (Plate LXVIII. fig. 3,)—the improved lithotriptor of Leroy d'Etiolles, by which the crushing may be effected by the rack and pinion, or by percussion with the hammer when the stone is found unusually resistant—and the instrument as last modified by M. Civiale, seen in Plate LXVIII. fig. 1, with which the crushing may be effected with a screw, or if necessary by resort to percussion. This latter instrument, which is well manufactured by Messrs. Schively and Rorer, of this city, the author has found admirably adapted to the operation. The handle of the hammer, as shown in Plate LXIX. should be made thin and elastic. The two other instruments, absolutely necessary to complete the lithotriptic apparatus, consist of the sliding duck-

* The instrument of Heurteloup, with the three-branched or windlass screw, I have several times employed with success, and consider on the whole, though less neat in its construction, superior to that of Leroy. The objection to the latter, distinguished by its inventor as the *percuteur perfectionné*, is the narrowness of the space for the application of the pinion, in individuals where there is much *embonpoint*, and the thighs are muscular and large. This may be obviated in many cases by turning the instrument, after it has grasped the stone, so as to allow of the vertical application of the pinion. But in attempting this I have occasionally been embarrassed by the bladder being excited to spasm, so as to drive some of its contents out through the urethra, and bring its walls around the end of the instrument.

billed forceps of Civiale, worked merely by the force of the palm, which will be found most convenient for the pulverizing of small fragments or larger-sized gravel, and the *articulated curette* of M. Bonnet for the removal of fragments lodged in the urethra. The latter instrument is constructed somewhat like the exploring sound of Amussat described at page 326; the principal difference being that the curette is introduced straight with the slender shaft of the instrument, and turned so as to form a right angle, by acting on the screw of the stilet after it has been passed behind the fragment. In several instances I have found a long slender pair of ear polypus forceps answer admirably well in the removal of fragments from the anterior part of the urethra.

Operation.

Preparation.—Previous to undertaking the operation, the patient should be placed in as good a state of health as the nature of the disease will admit, and the urethra well prepared by the previous use of the bougie, especially if found at all narrowed at any part, or unduly sensitive. When there is much irritability of the bladder, it will be found occasionally useful to throw in mucilaginous injections from time to time through an ordinary catheter, during the course of preparatory treatment.

Position.—The patient should be placed with his buttocks on the side of the bed, his feet supported on a couple of chairs, the knees widely separated, and the trunk supported in a semi-recumbent position with pillows. The surgeon is to be seated on a chair between the patient's knees. If the patient be a female, she may be placed nearly horizontally, with her hips elevated on a pillow, and near to the foot of the bed—her feet resting on a couple of stools. If the patient has not been able to retain his urine for several hours previously, the operator is to inject a mucilaginous decoction through a catheter till some tendency to pain is felt, or some fulness is apparent in the hypogastrium. The surgeon should never attempt to manipulate in an empty bladder, as the spasm excited under such circumstances would not only interfere with the seizing of the stone, but would expose the lining membrane of the organ to injury. In those instances in which the stone had for a long period occasioned incontinence of urine, and the bladder could not be made to retain an injection of more than a couple of ounces of fluid, I have found the manipulation upon the stone greatly facilitated by filling the cavity with sweet oil thrown in through a catheter.

One of the lithotriptic instruments above mentioned is to be introduced with the jaws closed into the bladder, in the same

manner as a sound or bougie. When assured by the freedom with which the curved part can turn, that it is fully within the cavity of the organ, it is to be gently moved onwards, and, if necessary, depressed till the heel of the curve is felt in contact with the stone. The surgeon then opens the instrument. This is to be done without giving any shock to the bladder, by grasping the lithotripter firmly with the left hand near the pubis, and drawing on the movable slide with the right. A quarter turn is now made with the instrument. This places the stone between the jaws. The sliding blade is then pressed down with the right hand, and the stone is firmly seized, and is now ready for division after having been moved a little from side to side to ascertain that the mucous membrane is not included in the grasp. If, as is frequently the case, the stone is found soft, an attempt may be made to crush it by pressure with the palm. If it yield to the effort, the blades may again be opened and one or more of the larger fragments further comminuted. When the bladder is tolerant, the stone, though large, may, if soft, by two or more repetitions of this process, be so thoroughly crushed as to leave little to do at a second sitting. But when much pain is excited or spasm of the bladder ensues, the operation must be no longer protracted. From ten to twelve or fifteen fragments have in this way in favourable cases been separately crushed at a single sitting. But in no case should the operation be protracted over ten or twelve minutes, and in most instances it would be imprudent to continue it for half this length of time.

If the stone is found too hard to yield to pressure with the palm, the screw or the pinion, according to the instrument used, is to be employed to close the blades for the purpose of crushing it. If the stone should be found too solid—an occurrence but rarely met with—to yield without the application of such force as would incur a risk of bending or breaking the instrument, then only will it be necessary to resort to percussion. For this it is necessary to give a quarter turn to the instrument so as to present its curved end upwards, and raise the stone, now tightly grasped between the jaws, from the bottom of the bladder. The surgeon then secures the instrument, so as to render it perfectly immovable, by one of the processes shown in Plate LXIX., and strikes with the little hammer a few slight, rapid blows upon the button at the outer end till the stone is felt to yield. The fragments into which it is divided are now to be separately seized and broken with the screw. After the completion of the operation, the fragments are to be shook or displaced, by some rapid movements of the sliding or male branch, from between the jaws of the instrument, so that it

PLATE LXIX.—LITHOTRIPSY.

The exhibition of the parts is the same as in the preceding plate.

(A). Line of section of the hypogastrium. (B). Os pubis. (C). Posterior surface of the bladder. (D). Peritoneum.

Fig. 1.—Operation by percussion, after the manner of Leroy d'Etiolles.—The stone is seized between the teeth of the *percuteur perfectionné* of this surgeon. The instrument is grasped firmly in the left hand of the operator (a), and is furthermore sustained by the two hands of an assistant (b, c), so as to resist the shock which the surgeon gives to the male blade by striking its end with the hammer (d).

Fig. 2.—Another method of the same surgeon, of holding the instrument with the two hands of the operator (e, f), the hammer being applied by an assistant.

Fig 1

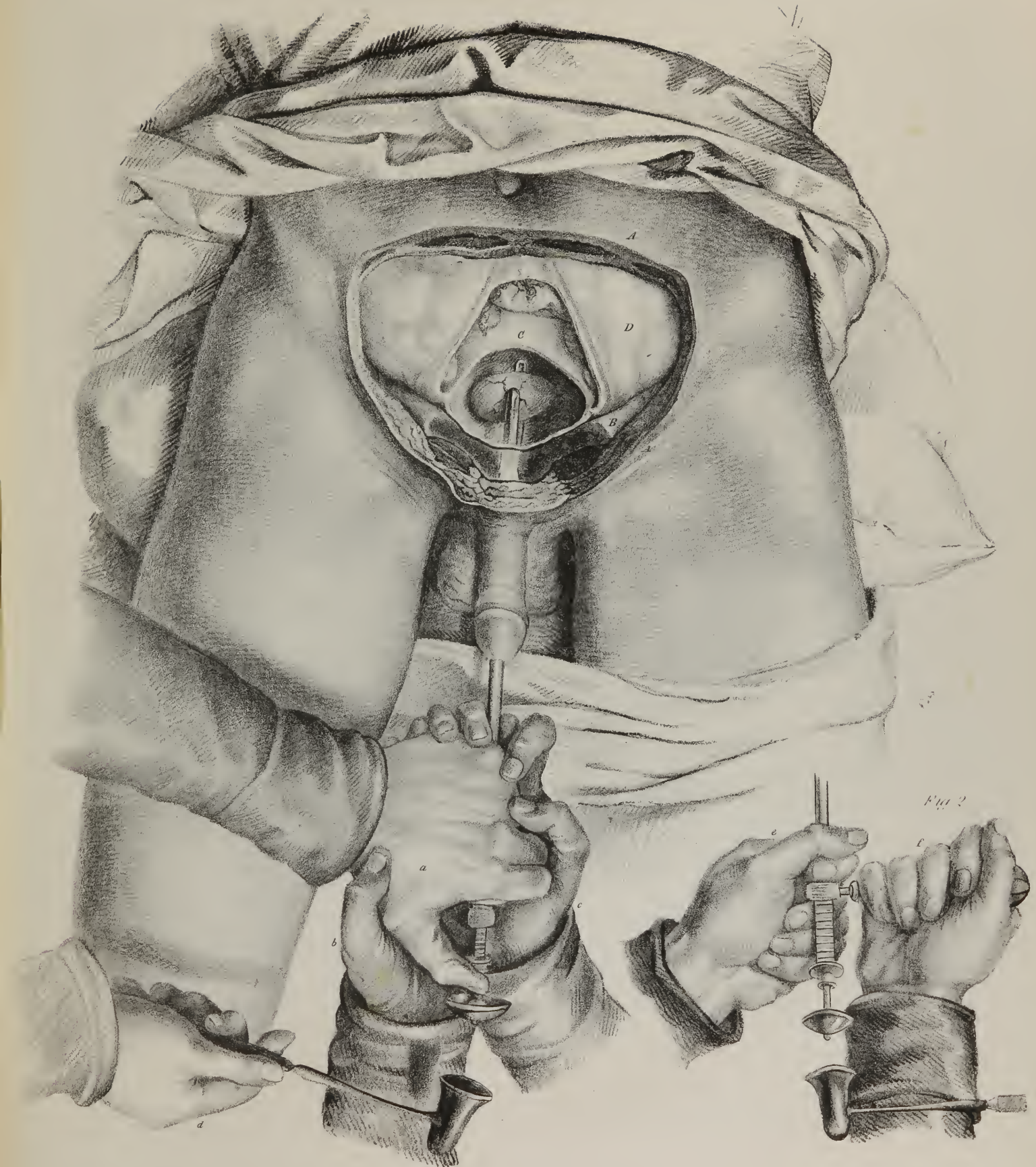


Fig 2

may be completely shut—as made manifest by the examination of the outer end—before an attempt is made to withdraw it. If it be withdrawn with the jaws held more or less asunder by granular or triangular portions of the stone, the urethra is liable to be lacerated, and the instrument may even stick so tightly in the membranous or navicular portions of the canal as to occasion the patient much pain, and give no little trouble to the surgeon.

The *brise-pierre*, or lithoclast, of Jacobson is to be employed almost precisely as in the process just given. From the more regular catheter-like curve of its end, it is introduced with great facility. When in the bladder, the chain loop is expanded by pushing down the sliding blade. The loop is then made to sweep lightly over the bottom of the bladder till it embraces the stone. The movable blade is then retracted, and the stone, if soft, may be crushed in the effort thus made to close the loop. More commonly it will be found necessary to apply the screw. With this instrument percussion cannot be practised. The *brise-pierre* is at present much less employed than the instrument more commonly designated as the proper lithotripter. The author has, however, seen it, as well as the latter instrument, most skilfully employed in many instances by Dr. Jacob Randolph, of this city, and has used it advantageously himself. The principal objections which he has noticed in regard to its use are, the strain which it makes on the neck of the bladder by the disposition of the lower end of the blades to separate on the expansion of the loop, (especially observable when the bladder is but moderately distended,) and the difficulty at the conclusion of the operation in closing the instrument completely, in consequence of the granular portions of the stone getting in between the blades.

When the operation is over, the patient urinates and discharges the detritus and some of the smaller fragments of the stone. If it be convenient, he should, in the course of an hour or two, take a warm bath, and again empty the bladder. He should be placed on a mild diet, take mucilaginous drinks, and keep his bed at least for the day succeeding the operation. If on the third or fourth day he continues to urinate frequently and with a sensation of pain, it is probable that some large fragments still remain. The instrument may then be re-introduced, and the operation repeated as before. Many successive repetitions of the crushing process may in some instances be required. When the fragments are small and numerous, the use of the duck-billed instrument of Civiale will, as before observed, be found particularly appropriate, from the ease with which it scoops up the pieces, and the facility with which it may be opened and shut. It is not necessary, however, that the fragments should be pulverized, as pieces of considerable size will be driven out with the flow of urine, and ordinarily with but little risk to the urethra, as the sharp edges left on their separation from the parent calculus will be found rounded off by exposure to the urine in the cavity of the bladder.

If much blood, in consequence of injury to the prostate, should accumulate in the bladder, it, as well as the detritus of the stone, may, if deemed necessary, be washed out by injections into the organ with a common catheter, or, which answers much better, one with a double current.

Of the various accidents which may follow the operation, the retention of urine, fracture of the instruments when those of an inferior sort have been employed, inflammation of the prostate,

bladder, testicle, or peritoneum, it will not be necessary here to speak, as they will require to be managed nearly in the same manner as when developed under other circumstances.

“Like many other novelties,” says Professor Fergusson,* “lithotripsy has undoubtedly been too much vaunted by its professed advocates and performers; but it is equally clear that in many instances it forms an admirable substitute for lithotomy. Notwithstanding the reputed success of Civiale, it seems to me that in the present stage of its history we have not sufficiently authentic data by which to determine the comparative safety of lithotripsy† to that of lithotomy; but regarding the applicability of the former, and even its superiority in many instances, there need be no doubt. Years must yet elapse, and the operation must be tested in our public hospitals by the same class of surgeons as those on whose proceedings the statistics of lithotomy have been founded, before an unbiased professional judgment can be given on the subject.

“There are certain circumstances adverse to the success of lithotripsy, which should always be inquired into, ere it is determined to resort to this operation. The diameter of the urethra before the age of puberty is most unfavourable, both on account of the smallness of the instrument which must of necessity be used, as also that the fragments cannot pass away in such large portions. Besides, in early years the urethra and bladder are more irritable—less callous to the contact of the needful apparatus. At any period of life a small urethra is objectionable on the above grounds, whether there be stricture or a natural want of development. Any obstruction to the free passage of instruments or of urine must be a great hindrance, and in advanced years the natural enlargement of the prostate, and what may be termed the diseased enlargement, present impediments which the utmost skill may not be able to surmount. Should the bladder be sacculated—a condition which can scarcely be ascertained on the living subject—the chances of success will be further diminished; for, supposing the stone to be broken into various fragments, the probability of some of these lodging in such pouches must always render the results of the proceeding uncertain. But from my own experience I should say, that the most formidable objection to lithotripsy is the apparent irritability of the urinary organs; if the patient does more than wince while being sounded; if the application of the steel to the urethra seems to occasion pain—I mean more than that sensation which patients usually have on such occasions—if the mucous surface of the bladder is so tender as to cause the contact of the instrument to be borne with difficulty; and if the muscular fibres are excited to such violent contraction as to occasion the evacuation of the fluid contents along the side of the instrument, or to excite an irresistible desire to micturate, then assuredly the circumstances are peculiarly unfavourable to the proceeding. A stricture may be cured; the natural calibre of the urethra may be increased by dilatation; even in certain cases the objectionable state of the prostate may be in some measure overcome by means of large catheters, scoops, and proper position whilst voiding urine; but the irritability—excitability, I may call it—and tendency to inflammation, which are almost certain accompaniments, cannot so readily

* Practical Surgery, pp. 601-602.

† By many writers lithotripsy or lithotripsy is applied to designate both the original grinding or drilling operation, and that of crushing or lithotripsy. In the latter sense it has been employed by Mr. Fergusson.

be coped with. It is very certain that in some instances the organs become more and more callous after the application of instruments; but it is equally certain that the conditions above referred to often rather increase than otherwise, after the first, second, or third sitting; and, in addition, that in certain cases, where the conditions have not been by any means conspicuous before the operation, they have become so developed as to retard the whole proceedings, making each succeeding attempt more painful than the preceding one, so that the cure (if cure it can be called) is ultimately completed amidst the most miserable sufferings—miserable to the patient, and disheartening to the surgeon,—when, from time to time, as a favourable opportunity presents, he has again to resume his attacks upon the original cause of the suffering—the stone—which may at this time be already comminuted into a variety of fragments.

“While I do not hesitate to assert that the above picture is by no means overdrawn, it must be admitted that the effects are very different in the majority of cases in which lithotripsy is properly applicable: and here, be it remarked, there is a vast difference between such examples and those in which, unfortunately, it is attempted; for when the circumstances are favourable, viz., when there is a large and callous urethra, a capacious and apathetic bladder, (if I may so call it,) with good muscular power, a healthy prostate, and a small or moderately-sized stone, the operation may be done once, twice, or as often as may be required, with as little annoyance to the patient as if he were only undergoing the treatment for stricture.”

LITHECTASY.

A new method of removing calculi from the bladder of the male without incising the prostate, entitled “lithectomy,”* or “cystec-

* From *λίθος*, a stone, and *εκτασις*, dilatation,

tasy,” has within a few years been strongly recommended by Dr. Willis, of London.* It consists first in making an incision a few lines long into the urethra exactly in the median line and behind the bulb, and then slowly and patiently dilating the membranous portion and the prostate with sponge or gentian tents, or Arnott’s dilator, till sufficient room is obtained for the introduction of the forceps into the bladder and the removal of the stone. The incision or button hole opening into the urethra should be made upon a grooved staff.

Mr. Elliot, of Carlisle, (England,) who has practised the operation successfully in one instance, believes that advantage will be derived in the subsequent steps of the process from a larger external opening. He makes the external incision as in the common lateral operation for stone, and opens the membranous portion in its whole length, from the prostate up to the bulb. The dilatation is effected by Mr. E. with the fluid pressure dilator of Dr. Arnott, an admirable instrument for the purpose, which has already been referred to at p. 325 of this work. The length of time required for the dilating process will of course vary with the resistance of the prostate and the degree of force employed. Dr. Willis has mentioned thirty or forty hours as the usual period. But Mr. Elliot believes it may be much sooner accomplished, and with less suffering if Arnott’s dilator be used, and a small additional quantity of mucilaginous fluid be thrown into the bag every quarter of an hour. Previous to the operation, the membranous portion and the prostate, as directed by Mr. E., should be dilated as far as possible by the use of bougies.

* Mr. John Douglas appears to have been the first who directed his attention to this subject. In 1819, Drs. Neil and James Arnott, assisted by Sir Astley Cooper, applied the process, for the first time, upon the living subject, but their success was not such as to bring the operation into general favour. M. Guérin, of Bordeaux, devised a proceeding somewhat similar, but which was in this respect objectionable, that the incision of the urethra was continued from the urethra through the sphincter ani into the rectum.

PLATE LXX.—LITHOTOMY IN THE FEMALE.

Figs. 1, 3.—*Super-pubic or high operation*, as practised in either sex. An incision has been made through the linea alba above the pubis, and an opening made through the anterior wall of the bladder. In the stage of the operation shown, the surgeon sustains the upper angle of the vesical incision with the forefinger of the left hand (*a*). An assistant draws off one of the lips of the wound in the bladder with the blunt hook (*b*), while the surgeon, with the curette in his right hand (*e*), raises the stone from the lower fundus of the bladder. The surgeon then, as shown in fig. 3, gives the curette into the hands of an assistant (*c*), who sustains the stone while the operator grasps and removes it with the forceps applied with both hands (*a, b*).

Fig. 2.—*Puncture of the bladder in the above operation*, shown after the incision of the linea alba, in a section of the male pelvis. (A). Symphysis pubis. (B). Line of section of the abdominal walls. (C). Reflection of the peritoneum on the top and posterior surface of the bladder. (D). Bladder in a state of partial distension. (E). Left forefinger of the surgeon, which breaks away the cellular tissue so as to expose the front surface of the bladder, and serves as a guide to the bistoury (F), with which the bladder is punctured between the finger and the symphysis pubis.

Fig. 4.—*Vestibular operation.*—The labia majora are separated by the two fingers of an assistant (*a, b*). A catheter passed through the urethra is depressed with the left hand of the surgeon (*c*) so as to make the vestibulum tense while he incises it with the bistoury in his right hand.

Fig. 5.—*Incision of the urethra upwards.*—The mons veneris is pressed upwards with the right hand (A) of an assistant. (B). A grooved director; with this the surgeon depresses the urethra with his left hand towards the vagina, and divides its upper wall with a bistoury in his right.

Fig 1

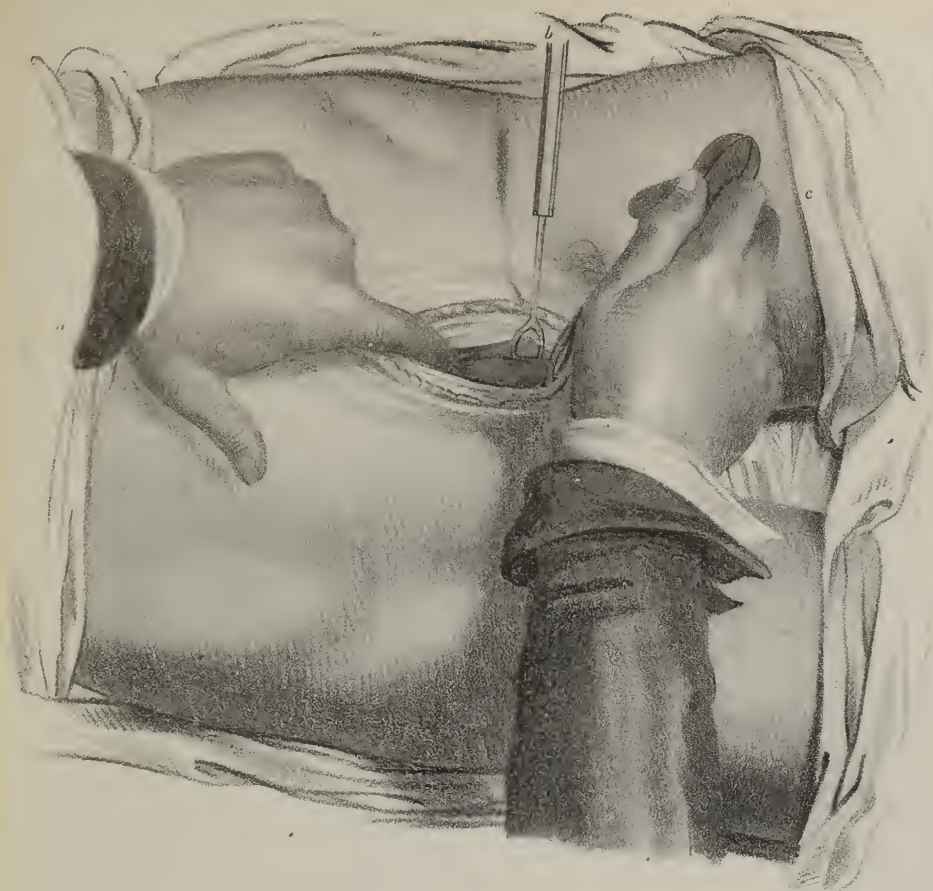


Fig 3

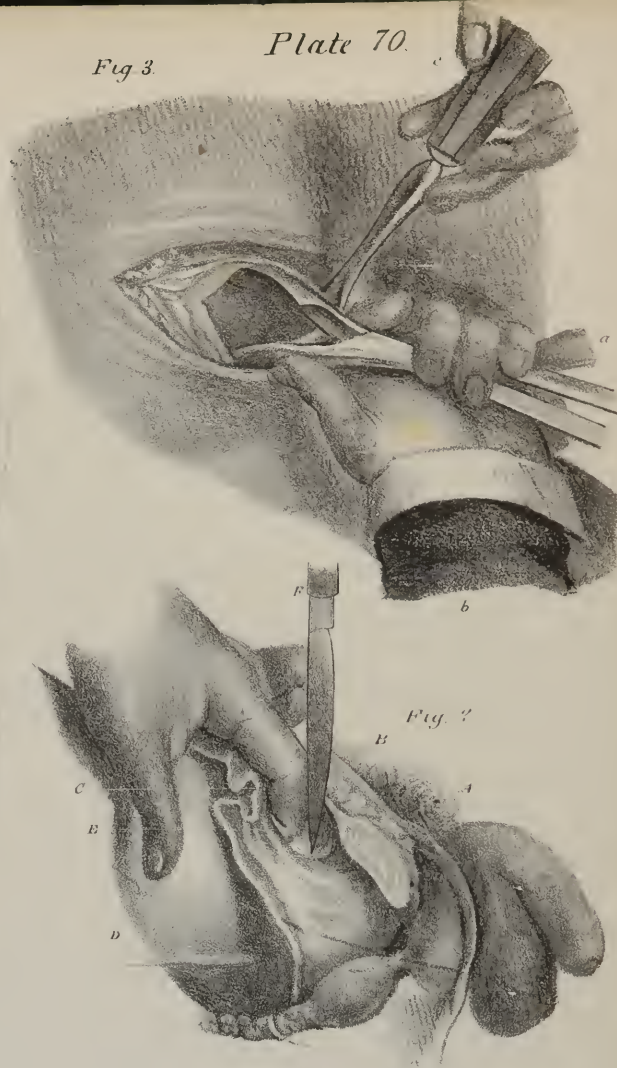


Plate 70.

Fig 2

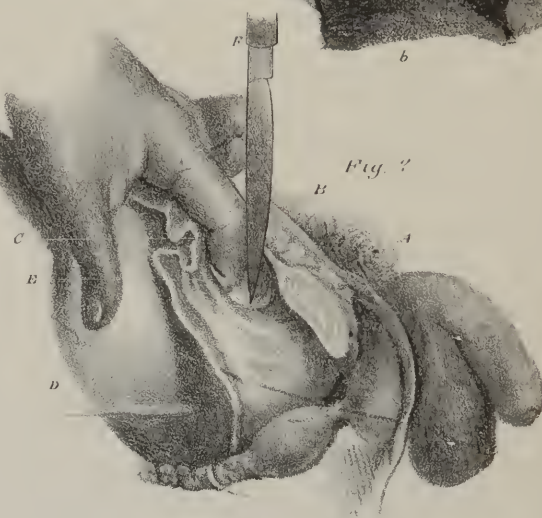


Fig 4

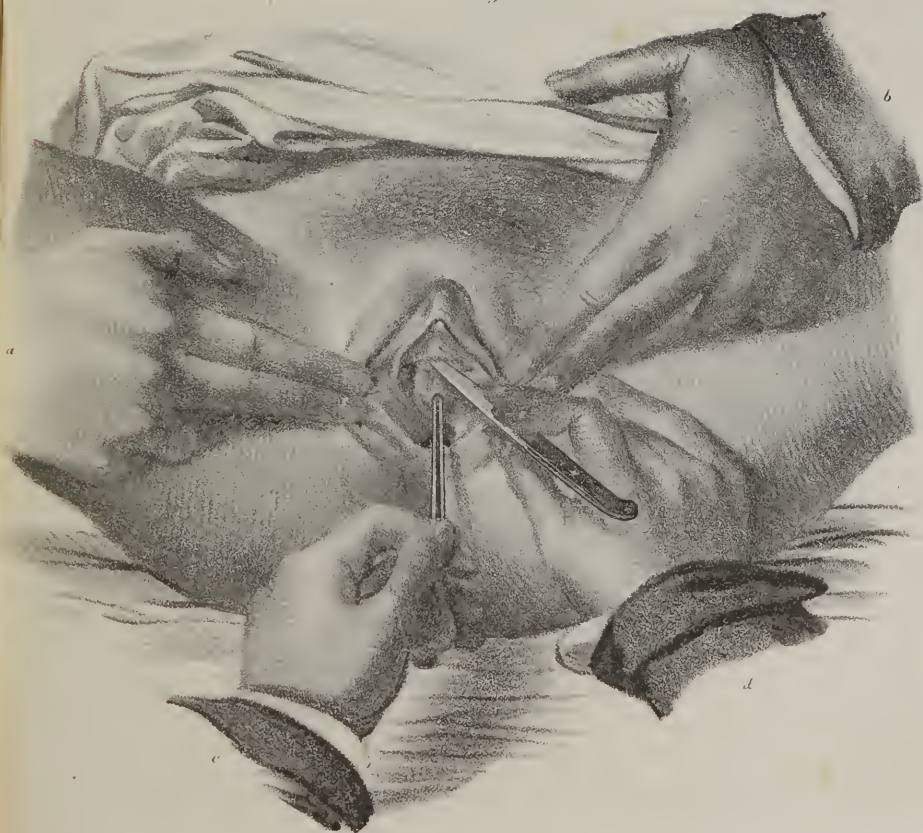
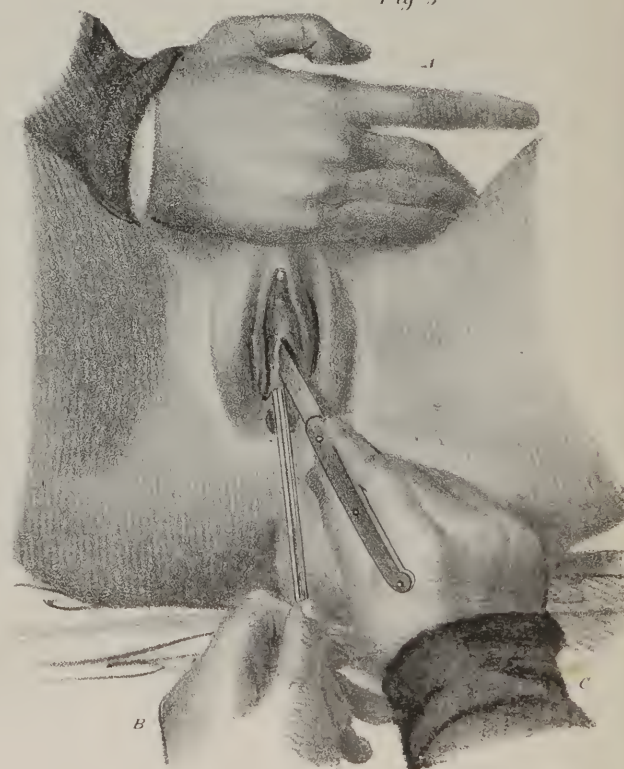


Fig 5



Another advantage arising from a large external incision, besides that of getting more ready access to the passage, is, that the prostate, provided it does not readily yield to dilatation, may be divided on one side with the knife, and the process completed as in the lateral operation for stone.

The operation of lithectasy has been successful in the hands of its inventor, and in two cases in which it was employed by Mr. Elliot and Mr. Wright of Dalton. It terminated fatally in a case operated on by Mr. Ferguson at King's College Hospital. Mr. Ferguson made the external incision in the perineum in the shape of an inverted Λ for the purpose of getting readier access to the urethra.

The cases above cited, serve to show that stones may be extracted from the bladder by lithectasy, but it yet remains to be proved, a circumstance extremely doubtful, that the process presents any advantages over the ordinary operation by lithotomy.

OPERATIONS UPON THE GENITAL ORGANS IN THE FEMALE.

This section comprises operations for Stone; Suture of the Perineum; Recto-vaginal and Vesico-vaginal Fistulæ.

LITHOTOMY IN THE FEMALE.

In the female it can seldom be necessary or justifiable to cut for stone. The shortness of the urethral passage, the facility with which it may be distended by the calculus itself, by the introduction of a sponge tent, or by dilating force more suddenly applied, render possible the discharge of stones of considerable size through the urethral canal by the natural efforts of the bladder. The author has in two instances succeeded in removing stones from the external orifice of the urethra, of a diameter three or four times as great as the undilated canal. In case the stone is not in this way dislodged, the surgeon has a resource nearly infallible in the lithotriptic or crushing operation. It is difficult, in truth, now that the operation just referred to has been brought to its present high degree of perfection, to lay down any positive indication for the performance of lithotomy in the female. But cases requiring this operation may occur, one of which has within a few months come under the care of the author, where the stone is of large size, the spasmodic irritability of the bladder extreme, the organ itself habitually contracted down to such dimensions as to prevent the opening of the lithotripter to the requisite extent, and the patient so worn down by suffering as to render some immediate measure of relief absolutely necessary. It is, nevertheless, occasionally practised by some surgeons, and especially in children, who do not as a general rule bear as well as older subjects the frequent introduction of the lithotripter into the bladder. The extreme repugnance with which surgeons of experience regard lithotomy by a perineal operation in the adult female, is not from any immediate danger accruing from the operation, but the very probable entailment for life of incontinence of urine—one of the most disgusting and loathsome affections. In consequence of this, if any cutting operation were deemed requisite in the adult female, the

super-pubic or high operation, described at page 336, might be deemed the most appropriate. But this, though less dangerous in the female than in the male, in consequence of the greater breadth of the female pelvis, is nevertheless accompanied with much risk to life; and the surgeon, who should look to the prolongation of human existence as a principal object, ought, even with the risk of an incontinent discharge of urine, to decide in favour of one of the operations by the perineum—that by incision of the urethra upwards being, in the author's opinion, the one that should in most cases be chosen. In infants the incontinence of urine follows much less frequently than in adults, as a result of the division of the neck of the bladder from the perineum. This operation is performed in the female by four different processes—by an incision through the vestibulum; by a lateral cut from the urethral passage; and by an incision from the urethra downwards into the vagina, or upwards towards the symphysis.

At the Vestibulum.

Surgical anatomy.—The object of the incision of the vestibulum, is to reach the bladder without dividing the urethra. The vestibule is a triangular space included between the clitoris, the nymphæ, and a transverse line drawn across the anterior boundary of the urethra. The urethral canal in the adult is from an inch to an inch and a quarter long, runs obliquely upwards and backwards, and is slightly concave on the surface next the pubis. It gradually increases in diameter from the external orifice up to the bladder. Its structure is simple, and may be compared to the membranous portion of the urethra in man, but is surrounded by no prostate gland. It rests on the anterior face of the vagina, to which it is united by some dense semi-erectile cellular tissue. It is found about a third of an inch below the sub-pubic ligament, to which it is united by some elastic cellular tissue, that yields on depressing the canal, so that the distance between the latter and the symphysis can be increased to an inch. In cutting through this space up to the bladder, we divide in succession the vestibular mucous membrane, the elastic cellular tissue, the constrictor vaginæ muscle, the anterior ligaments of the bladder, and lastly the neck of the bladder itself.

Operation. (Process of Lisfranc. Pl. LXX. fig. 4.)—The patient is to be placed as for the lateral operation in man. Two assistants separate the margins of the vulva. A sound is introduced into the urethra, and pressed downwards with the left hand of the surgeon towards the vagina so as to distend the vestibular space. The surgeon then makes a semilunar incision in front of the urethra, as shown in the drawing. In making this incision the handle of the bistoury should be kept lower than the blade. The layers are to be divided in succession up to the bladder; the lower lip of the wound is then depressed with the finger, and the bistoury plunged into this organ so as to open it transversely. Through the transverse opening thus made the forceps are introduced for the removal of the stone. Neither the superficial perineal, nor internal pudic arteries run much risk of being wounded. The process, however, is not, according to the author, deserving of much reliance, as it does not afford sufficient space under the arch of the pubis for the extraction of a very large stone, and would be liable to give rise to an effusion of urine in the cellular tissue behind the pubis.

Urethral Operation.

There are several processes for the division of the urethra.

1. *Division in the median line towards the symphysis pubis.* (*Process of Collot*. Pl. LXX. fig. 5.)—An assistant applies the ulnar margin of the right hand upon the mons veneris so as to extend the vestibulum. The surgeon then introduces a grooved director through the urethra, runs a straight probe-pointed bistoury along the groove, and incises the upper wall of the urethra, the cellular tissue above it, and the neck of the bladder in the direction of the symphysis pubis. The instruments are then withdrawn; the left forefinger is introduced into the bladder, and serves as a guide to the passage of the forceps for the withdrawal of the stone. This operation has been many times performed with success, and is less liable to be followed by incontinence of urine than either of the two succeeding processes.

It was the one selected by the author under the circumstances referred to on the preceding page. The patient was a young lady, of slender and delicate form, twenty-two years of age. The stone was very large, weighing over an ounce and three-quarters. It was necessary, on account of the large size of the stone, to enlarge the incision by a second cut upwards on the side next the bladder. From the difficulty in withdrawing the stone, there was some laceration of the structures on the left side of the incision. The wound was carefully closed by three sutures, one of which occupied the middle of the urethral tract, so as to diminish as much as possible the risk of the operation being followed by incontinence of urine.

No vessels were cut that required ligation. A catheter was placed in the urethra, to check the capillary oozing, and left open to prevent the suction upon the divided vessels during the act of respiration, which seemed to draw the blood into the cavity of the bladder, when the external orifice of the catheter was closed. The patient recovered rapidly and *without incontinence of urine*.

2. *Division of the urethra in the direction of the vagina.*—This is a very simple operation. It differs only from the preceding in that the incision is directed downwards in the median line so as to divide the lower surface of the urethra, a part of the wall of the vagina, and the lower part of the neck of the bladder.

3. *Lateral operation.*—This consists in the introduction of a bistoury through the urethra on a grooved director, and incising the parts obliquely downwards in the same direction as in the lateral cut for stone in the male. This process has, however, been but little practised; it involves the division of the constrictor vaginæ muscle, the transversus muscle, the margin of the levator ani, as well as the urethra, perineal fasciæ, and neck of the bladder. The internal pudic artery occupies the same relative position as in the male, and is more or less exposed to injury. To get a freer opening, suited to the extraction of a larger stone than this process would allow, Dupuytren made a bilateral incision with a double lithotome, by a method nearly allied to that employed in the male.

SUTURE OF THE PERINEUM.

Surgical anatomy.—In obstetrical language, the perineum of the female comprises the whole of the space included within the bony outlet of the pelvis. Its antero-posterior and transverse diameters are each about four inches, though the former may be somewhat

increased by the retrocession of the point of the os coccygis. The perineum proper, however, consists of the triangular space between the vagina and the rectum. The base of this triangular portion presents to the skin, and is there from three-quarters of an inch to an inch and a quarter broad; its vertical diameter is about an inch and a half. Above this triangle the walls of the rectum and vagina, constituting a part which may be distinguished as the recto-vaginal septum, are closely united by dense cellular tissue, up to a point where the peritoneum is reflected off from between these organs, about three inches from the surface. The perineum of the female comprises the same fasciæ, vessels and nerves as the male. The fasciæ, however, especially the middle and inferior, which are found in the perineal triangle, are reduced to a cellular state, and are bifurcated in front for the purpose of surrounding the vagina.

The cellular structure of the perineal triangle is distended into a thin layer during parturition, to allow of the passage of the head of the fœtus. When it does not yield properly to the distension, or the child's head is unusually large and the labour rapid, the triangle, with the anterior margin of the sphincter ani muscle, may be ruptured near the median line; in some instances an opening has been made in it by the incautious use of the forceps or the crotchet. If the laceration extend further, so as to involve likewise the recto-vaginal septum, and lay the two passages of the vagina and rectum into one, it will constitute a deformity of the most distressing kind. If the degree of laceration be limited—extending merely to a little distance beyond the posterior commissure of the vagina—the cure will in most instances take place spontaneously, especially if, as directed by Chelius, the patient be laid upon the side, for the purpose of keeping the parts in closer approximation. In case the laceration be more extensive, the patient may be placed in the same position, with a towel pinned round the hips and thighs to keep the parts more completely at rest. The contused nature of the injury, the character of the discharges which inundate the part, but too commonly, in these cases, prevent union by first intention.

It has been proposed by M. Danyau, (*Journ. de Chirurg.*, 1843,) to unite the parts immediately by suture. In some instances it might be deemed advisable to apply at once a single stitch, which should take deep hold of the perineal margins. But if there be much swelling, and there is reason to believe that the vitality of the lacerated structures is greatly impaired, this course would be highly injudicious, it being infinitely better under such circumstances to wait till the parts have recovered their vital energies. The interrupted, the twisted, and the quilled suture, and the leaden wire ligature,* have been employed for the purpose of holding the sides of the fissure together. The quilled suture has, however, in the main, been found to answer best, as it not only keeps the surfaces more deeply in contact, but diminishes the tendency of the threads to cut out, which usually it is desirable to keep in place till a solid cure is obtained. This is always effected more or less by second intention, and is sometimes not accomplished under the space of a month. When the cure seems tardy, it will frequently be necessary to resort to washes or ointments of a stimulating character, to promote the growth of granulations.

* In the Amer. Journ. of Med. Sci. for 1833, a case is reported by Dr. J. B. Mettauer of Virginia, in which the leaden ligatures of Dieffenbach were employed with success.

Operation as practised by the Author. (Pl. LXX. fig. 1.)—The patient is to be placed as in the perineal operation for stone. The borders of the fissure, if they have become callous or lacerated, are to be excised with the knife, or a pair of scissors which the author has commonly found to answer best. From three to four or five double ligatures are to be passed with a needle deeply through the edges, embracing the integuments of either side to the extent of an inch. These are to be secured, as shown in the drawing, over portions of a bougie or quill. In case the fissure has extended up through the recto-vaginal septum, two interrupted sutures should be introduced with a fine needle, to approximate the edges previous to the closure of the perineum. If much tension of the integuments is made by the quilled suture, it should be relieved, as recommended by Dieffenbach, by a semilunar incision on either side, as shown in the drawing. In the after-treatment the greatest care is required to preserve the parts in a state of perfect cleanliness. The urine should be drawn off with a catheter, and, for the first few days succeeding the operation, the action of the bowels should be arrested by the use of opiates and astringents. When it becomes necessary to have the bowels opened, the accumulated feces may be washed out through a tube by repeated injections of soap and water. Even after the cure has been completed the patient has for a considerable time to continue the use of baths and emollient applications in order to soften the cicatrized parts, and should for a long period avoid any occurrence liable to produce a new laceration.

In a case which came after parturition under the care of Dr. Warrington of this city, and for which I operated a few months ago, the result obtained was so successful that it may be well to mention the mode in which it was brought about. The patient was young and the laceration very extensive, involving not only the perineum, but about two inches of the recto-vaginal septum. The two external orifices being thrown into one, it was difficult to distinguish the boundary between the rectum and vagina. I therefore laid a good sized tallow candle in the back part of the cloaca to insure sufficient dimensions for the rectum, and excised on each side, immediately in front of it, a strip of mucous membrane with a pair of ectropion forceps and curved scissors. Four interrupted sutures were then passed deeply at the sides so as to bring the raw surfaces together just in front of the candle, which was then removed. The gap in the perineum was closed with the quilled suture as in the manner of Dieffenbach. The sutures were allowed to remain till near the completion of the cure, which took place at the end of three weeks. The knees were bound together, and ice applied constantly in a bladder to the perineum. The wound, after the first thirty-six hours, was washed several times a day with a solution of sulphate of zinc, gradually increased in strength from two grains up to fifteen or twenty, from which the greatest advantage appeared to be derived, in maintaining the tone of the parts and preventing free suppuration. At the conclusion of the treatment, lunar caustic in solution was substituted for the zinc. The cure was absolutely perfect, much of the credit of which is due to the skill and persevering attentions of Dr. Warrington.

RECTO-VAGINAL FISTULA.

A fistulous passage communicating between the vagina and rectum may result from the incomplete laceration or contusion of

the septum in difficult parturition, from unskilful use of the forceps or crotchet, or simply from the opening of abscesses in the direction of the two passages. Cases arising from the latter two causes have repeatedly come under the charge of the author. When small, he has with but little difficulty made them close under the occasional application of the actual cautery. If larger and placed immediately behind the anterior end of the sphincter, he has found it necessary to resort to the division of this muscle with the bistoury or ligature.

Process of Roux.—When the fissure is longitudinal, Roux has recommended the incision of the edges and the closure of the opening by two or more interrupted sutures, as shown in Plate LXXI. fig. 4. Where the opening is transverse, the same distinguished surgeon has dissected up a quadrilateral flap from the posterior part of the vagina, closing the opening by drawing the flap down over the fissure, and fastening it by suture below the margin of the posterior vaginal commissure, as shown in Plate LXXI. fig. 2.

Process of Velpeau.—In cases of large transverse opening, this surgeon, in imitation of the process of Jobert, (see page 346,) dissected up a flap of integument from the outer surface of the labium externum, twisted it upon its pedicle, and affixed it by suture over the vaginal orifice of the fistula, the edges of which he had previously made raw, or inflamed by the application of caustic.

Process of Barton.—The following ingenious operation was devised by Dr. J. R. Barton of this city, in the case of a young unmarried lady, for a fistulous passage which had formed as the consequence of an acute abscess in the region of the rectum and vagina.

“The fistula was found commencing about three-fourths of an inch within the labium of the right side, thence passing by a very irregular course up the pelvis and inclining towards the rectum; into which cavity it finally opened, about three and a half or four inches from its inferior aperture in the vagina. Through this sinus there issued fluids in sufficient quantity to keep the genitals continually moist. Flatus also at times found its way through this channel.

“The discovery of the real nature and the extent of this sinus, passing as it did from one to another important cavity, and establishing a communication between them, presented an embarrassing view of the case as to the mode of cure. It was now clear that the complaint must be treated with reference to its connection with the rectum, and upon the same principles that govern us in the cure of fistula in ano—for in fact it was virtually such a case modified by the unfortunate implication of the vagina.

“It was nevertheless apparent that this sinus could not be included in a seton and ulcerated through, nor be laid open, as usually done in the common fistula in ano, without destroying the perineum and laying these two great cavities into one!—thereby causing a more unhappy state of the parts than had previously existed. The duty, therefore, of the surgeon was very clear—either to consign the patient to a continuance of her loathsome complaint, or to adapt an operation to her peculiar case. The latter was successfully done, as follows.

“A fine tent was inserted, for a few days, to dilate the sinus, and to render its course less tortuous. A seton was then introduced, with an eyed probe, into the sinus *per vaginam*; thence

passed through its whole extent, until it had penetrated the rectum by the orifice into that cavity. It was then brought down and out *per anum*. The two ends were then loosely tied together merely for security against its slipping out. After a few days the loop was opened, and the end of the seton passing out of the vagina was put through the eye of a probe which was previously crooked at the other end. This probe was then inserted into the orifice in the vagina; thence about an inch and a half up the sinus, then its point directed towards the perineum, just exterior to the sphincter ani muscle. Here a small but somewhat deep incision was made, and the probe pushed through it; bringing along with it the end of the seton which had been doubled upon itself.

"The seton now, instead of passing out of the vagina, as at first, after coming down from the bowel, through only part of the sinus, descended through the new channel which I had made for it. The ends, lying almost side by side, were now tied together—thus forming a loop in which were included the parts between the

outer surface of the sphincter ani muscle and the rectum. This seton or ligature was subsequently drawn and twisted tighter and tighter from time to time in order to cause its ulceration through the included parts, as we do in common fistula in ano, when operating by the ligature or wire. So soon as, by these means, the new and direct channel was formed, and had attained a larger size than that penetrating the vagina, the discharges from the rectum deserted that portion of the rout which led into the vagina, and took the course of the seton. This was exactly the end which I designed to accomplish by operation; believing that if I could establish a freer and more direct passage for the escape of the fluids of the rectum than that *per vaginam*, the sinus opening into the cavity would heal *sua sponte*, and become permanently obliterated. My opinions were confirmed—for long before the seton had made its way out by ulceration, the vaginal portion of the sinus had healed, and the integrity of this organ had been restored. I had now only to pursue the treatment of this case as I should

PLATE LXXI.—SUTURE OF THE PERINEUM. VAGINAL FISTULA.

SUTURE OF THE PERINEUM.

Fig. 1.—*Suture of the perineum with the lateral incisions of Celsus as modified by Dieffenbach.*—The edges of the lacerated wound have been excised with the knife, and brought together by three points of the quilled suture. In order to allow the more perfect approximation of the surfaces, two lateral incisions have been made through the integuments.

RECTO-VAGINAL FISTULA.

Fig. 2.—*Cure by the process of Roux.*—The opening in this case existed between the vagina and rectum, a little distance from the cutaneous surface of the perineum. A quadrangular flap has been detached from the posterior wall of the vagina, and drawn downwards for the purpose of being fastened by suture to the margin of the fourchette, which has been made raw to receive the flap.

Fig. 3.—*Closure of a longitudinal fistula by suture.*—The vagina is distended with a bivalve speculum. The edges of the fissure, previously inflamed by the application of caustic, have been rendered raw with the knife. The needle is passed with a *porte-aiguille* (a), the surgeon steadying one of the lips of the fissure with a pair of rat-toothed forceps in his left hand (b).

VESICO-VAGINAL FISTULA.

Fig. 4.—*Plastic operation for the closure of the opening between the vagina and bladder. (Elytroplasty. Process of Jobert.)*—A flap has been detached from the surface of the labium externum, turned upon its pedicle, and fastened by suture over the margins of the opening.

Fig. 5.—*Suture of a transverse fistula. (Process of M. Deyber.)*—A catheter (a), enclosing a dart stilet, is introduced through the urethra. On the right side the stilet has been passed through the anterior lip of the opening, so as to lodge one of the sutures in the wound, and is shown passed again through the posterior lip to allow the other end of the ligature to be detached with the forceps.

Fig. 6.—*Excision of the edges of a longitudinal fissure by the aid of the forceps of M. Fabri*, one blade of which is constructed like the prongs of a fork. The upper blade, which is single and flat on its lower surface, is introduced by the urethra, and serves as a support to the pressure made by the forked blade on the edges of the fissure. The knife is seen applied for the excision of the edges.

Figs. 7, 8.—*Closure of the orifice by a plastic operation. (Process of Leroy d'Etiolles.)*—In fig. 7 is shown the outline of a flap (a), detached from the posterior face of the vagina at the anterior extremity of the canal.

In fig. 8, which is a profile view on a section of the pelvis, the flap (a) is reversed, so as to present its raw surface to the margins of the fistulous opening, which have been previously inflamed with caustic. The end of the catheter (b), passed from the bladder into the vagina through the fistula, is made to receive the threads of a double quilled suture, by means of which the flap is held against the vesico-vaginal septum.

Fig 7

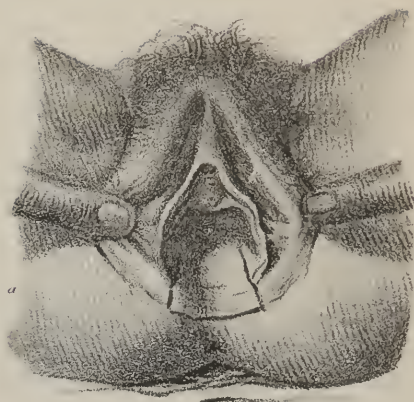


Fig 8

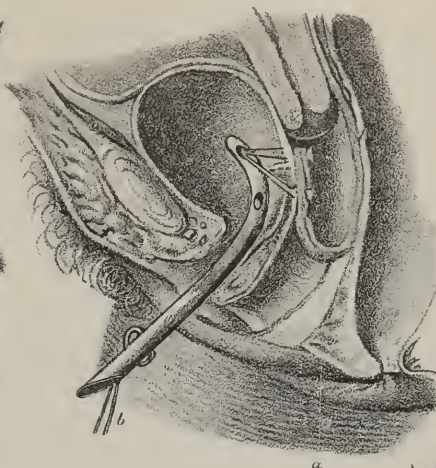


Fig 2

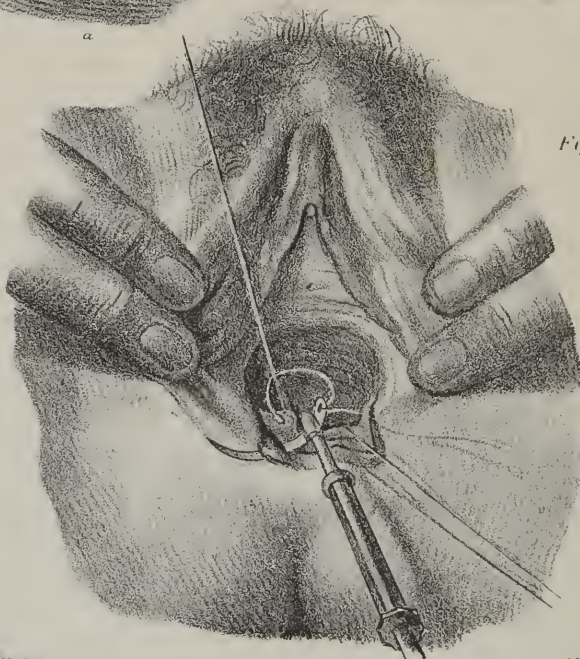


Fig 4

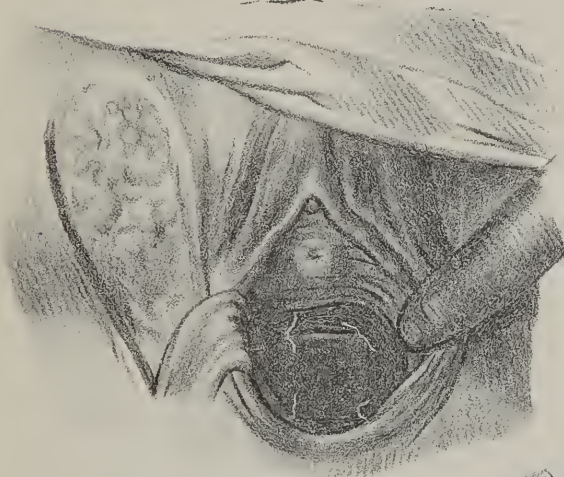


Fig 1

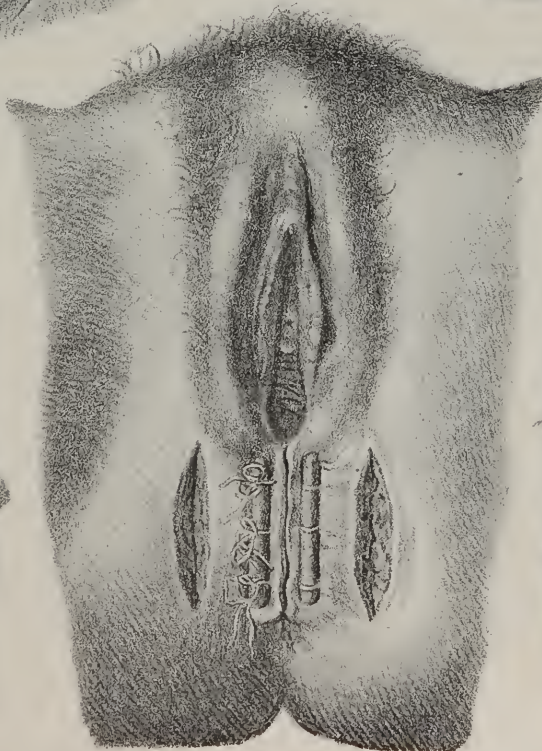


Fig 3

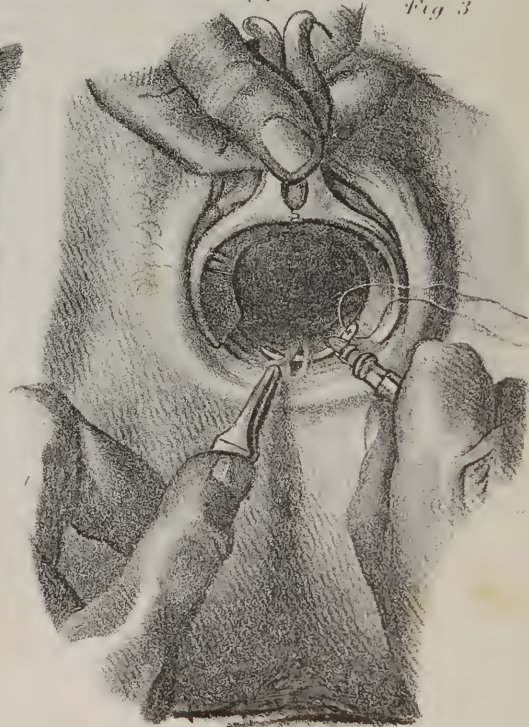
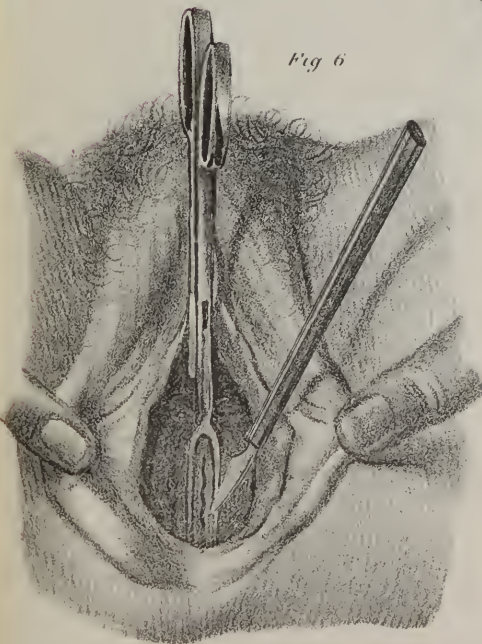


Fig 6



have done had it been a simple case of fistula in ano—viz., by continuing to tighten the ligature every day or two, until it finally came so nearly away that a slight clip by the scissors divided the insignificant intervening portion yet retaining it, when it was released. These parts healed up in a few days.”*

VESICO-VAGINAL FISTULA.

In this affection there is a fistulous communication between the bladder and vagina, by which the urine escapes either continuously or at intervals through the latter passage, constituting one of the most afflicting and disgusting maladies to which the female can be subjected. If the opening exist at the junction of the urethra with the neck of the bladder, and is not of large size, the bladder is capable of retaining a small amount of urine in its lower fundus. The condition of the patient is then less distressing, as the urine escapes only at intervals, and the patient by unusual cleanliness and care may preserve a certain degree of comfort. But if the opening is at the bas fond of the bladder, the urine in most instances dribbles away as it falls from the ureters, irritates and excoriates the vulva, the perineum, and the inner surface of the thighs, and spreads an offensive penetrating odour which causes the patient to exclude herself from the world, and in the end breaks down her general health by its sympathetic disturbance of the nervous system.

The fistula may be occasioned by ulceration from the lodgment of foreign bodies in the bladder, or from syphilitic sores; but in the great majority of cases it arises either from the unskilful use of obstetrical instruments, or from the detachment of a slough, the consequence of the long-continued pressure of the child's head in the lesser pelvis during parturition. The author has had two cases under his charge in which the affection was fairly attributable to laceration with the crotchet. When it is the result of a slough occasioned by the pressure of the fœtal head, or by that of a pessary which has been known to produce it, the flow of urine by the vagina does not immediately follow the infliction of the injury, as the slough in many cases is not detached till after the lapse of ten, twelve or fifteen days.

The diagnosis of this form of fistula is usually easy. When the urine is found to escape from the vagina, the nature of the affection is at once manifest. But this sign the author has found more difficult to recognize than would at first be imagined. In case of doubt, a coloured fluid may be injected into the bladder, which, if the opening exist, will readily be noticed in the vagina: or the vaginal passage may be explored with a bivalve speculum. The means of diagnosis which I have found most efficacious, consists simply of the examination of the vaginal passage with the finger conjointly with the introduction of a common catheter through the urethral passage. Lallemand recommends the insertion of a cylinder of softened wax into the vagina, for the purpose of taking an impression of the size and form of the fissure; but this process, though I have made repeated trials of it, has never afforded me any material assistance.

Of all the classes of surgical operations, those devised for this affection have been attended with the least satisfactory results. Prior to the time of Petit and Desault, it appears to have been

deemed wholly incurable—and the great degree to which modern surgeons have taxed their ingenuity in the invention of processes for its cure, without having established any that has received general confidence, serves to show the difficulties encountered in the treatment. These difficulties in recent cases consist in the deleterious influence of the urine on one side, and of the leucorrhœal discharges (which are nearly constantly observed) on the other, both of which offer obstacles to union either by first or second intention. In addition to these, when the fistula is large and of long-standing, the bladder becomes diminished in its capacity, and frequently has its upper fundus inverted through the opening; the vagina is moreover liable to become narrowed, and have its surface as well as that of the bladder covered with calculous concretions. Though small fistulous orifices may be obliterated without any particular difficulty, large openings from the causes above mentioned present obstacles to the cure that are nearly insurmountable. The various plans of treatment which appear entitled to the most confidence, may be classed under the following heads:—cauterization, suture and instrumental approximation, and plastic operations.

Cauterization.—This is effected either by the application of the nitrate of silver or the actual cautery, which are to be applied after distending the vagina with the speculum. If the former is employed, the walls of the fistula are to be touched with it from day to day, so as to develop a growth of granulations which may in the end block up the opening and solidly unite together. In this way the author has succeeded in occluding a fistula of the diameter of a large goose quill, seated near the neck of the bladder. If the actual cautery is used, the round or olive-headed iron should be chosen, and applied but for an instant merely to the vaginal surface of the fistula, as otherwise we might by the destruction of the margins increase the size of the opening. The object of the iron is to contract the opening, and at the same time excite the adhesion of its edges. If the orifice is large, it should be applied at a white heat at long intervals—if small, repeated every third or fourth day. Leroy advises the application first at a little distance around the margin of the orifice, for the purpose of diminishing its size by wrinkling the tissue, and subsequently to touch lightly the edges of the orifice with the iron. The author has tried this process, and in one instance with success, when the fistula was of such a size as to receive the end of the little finger; but the principal advantage appeared to be derived from the action on the margin of the orifice. When during the treatment the fistulous passage becomes obstructed by the swelling of its orifice, or by the granulations developed, the urine should be prevented from accumulating in the bladder, either by the retention of a catheter in the urethra or by resorting to its frequent introduction. If the fistulous orifice is of very large size, neither of the processes of cauterization will be found effective. The other forms of operation must then be had recourse to, an abridged account of which has been given as follows by Mr. Costello.

Suture. (Pl. LXXI. figs. 5, 6.)—“The suture in these cases is only employed as a means of keeping the fistulous edges in contact; and these must be previously disposed to unite by adhesion, either by the application of a caustic, or by paring with a knife. This operation of paring or resecting the edges of a fistulous opening in a movable fleshy wall, and deeply seated like

* Amer. Journ. of Med. Sci., Aug. 1840.

the vagina, is extremely difficult ; and this, indeed, is one of the reasons why the application of caustic is so often preferred.

"Various methods and instruments have been employed for this purpose. Sanson thought that the difficulty would be obviated by dividing the urethra with a *bistouri caché*, and then introducing his finger and drawing the fistulous edges downwards to the orifice of the vulva. In this manner the paring of the edges was readily effected, and the sutures applied ; but the cure was not effected. In another case, treated by Malagodi, of Bologna, he was enabled, by introducing his finger into the orifice of the fistula, to bring down gradually its two sides, and pare off the edges with a bistoury. M. Roux employed in another case two pairs of forceps, constructed to hold the right and left sides of the opening. When applied, the under blade of each instrument being wider than the upper, presented a fixed surface, on which the edges were easily cut. A curved suture needle was then passed, followed by its wire, by means of a *porte-aiguille* or needle-holder, from the left edge into the bladder, coming out through the right edge. Three points having been thus placed, they were twisted and protected with a pledget of charpie. The operation, which lasted nearly two hours, was unfortunately followed by an attack of peritonitis, which ended fatally. The methods just mentioned, however, were only applicable to cases in which the direction of the aperture was longitudinal.

"The method recommended by Velpeau is thus described by him : 'The patient is placed on an elevated bed or table ; a rolled mattress is placed under the belly, so that she may bend her thighs while she lies on the abdomen. An assistant keeps the vagina dilated by means of a wide groove of wood, horn, or metal ; the posterior and anterior angles of the opening are divided, the former with a straight scissors, the latter with a bistoury, to the extent of a line or two, in order to facilitate the seizure of the edges on either side with a good staphyloraphy forceps, and their resection by means of scissors, either straight or curved on the flat. The points of suture are then placed three or four lines outside the resected edges ; the edge is held with the forceps while the needles are being passed, and each point is twisted or tied by means of the fingers. If the opening be transverse, the edge may be easily resected by means of a bistoury curved on the flat, and very sharp near its point, the edge being raised or lowered by means of a proper pair of forceps.'

"The difficulties attending the placing of points of suture are, however, it is to be hoped, in a fair way of being removed, or at least diminished considerably. With M. Colombat's spiral needle, a suture-scam can be easily made in the vaginal wall ; and this, as well as the improved *porte-aiguille*, may lead to more numerous successes in this embarrassing point of surgery.

"To place before the reader some of the most practical of the modes proposed and practised, we shall take them in the order of their succession as to time. At the commencement of the present century, M. Lewziski proposed, in a case of transverse fistula, to place the sutures from within the bladder, by means of a needle fashioned like a *sonde à dard*, and introduced through the urethra. This instrument was subsequently improved by M. Deyber.

"In 1825, M. Lallemand, of Montpellier, invented an instrument whereby the lips of a transverse fistula could be brought

into, and maintained in contact during the time necessary for their adhesion, without sutures. This instrument, which he termed *sonde-érigne*, consists of a thick canula, four inches long ; a double hook, or two double opposing hooks, that can be projected from, or drawn into, the canula at pleasure ; a circular disc at the outer end of the canula, to prevent its slipping into the bladder ; and a spiral ring, by means of which the hook introduced into the posterior lip of the fistula can be brought forward. The canula is introduced through the urethra, and the hook is projected through the vesico-vaginal wall, just beyond the posterior lip of the fistula, and upon the surgeon's fingers. The front of the urethra is protected from any undue pressure which the disc might make on it, by means of a pledget of lint. The spiral ring then acting, brings the lips of the fistula in contact, by bringing the hook forward, and forcing the anterior lip backward. The degree of apposition necessary to union can be nicely regulated, by means of a particular mechanism. The vagina should also be protected from the contact of the hook, by a pledget of lint. M. Lallemand states, that he has succeeded in seven cases with this apparatus. He does not refresh the edges of the fistula by incision ; he simply cauterizes with the nitrate of silver.

"Dupuytren invented an instrument, also, for the purpose of approximating and holding the lips of the fistula in contact, which, being previously cauterized, were thus disposed to unite. This instrument was a large female catheter, furnished at its sides with two flaps or wings, that could be expanded or closed at pleasure by a central rod. When this sound was introduced into the bladder and the wings developed, on being drawn outwards, the posterior edge of the fistula was drawn towards the anterior, which was also pressed backwards by means of a pledget of charpie.

"*Cure by the application of a flap taken from the neighbouring integuments.* (Pl. LXXI. figs. 7, 8.)—The idea of extending the application of plastic surgery to the loss of substance in the vesico-vaginal wall, was first propounded by M. Jobert, in 1836. In effect, there is no greater difficulty in obtaining a flap from the labia, groin, or buttocks, for the purpose of closing a solution of continuity in the vagina, than there would be in detaching one from the forehead, in the operation of rhinoplasty ; and although the object of the transplantation is different, the steps of the operation itself are nearly the same.

"The edges of the fistulous aperture are first refreshed by incision, which M. Jobert affirms to be of easy execution, as they can be brought down by moderate well-directed traction, or by introducing the finger into the aperture. When the edges of the opening are pared, a flap of proper size and thickness (the skin alone would not suffice) is then formed, with a pedicle of sufficient substance to insure nourishment for the flap ; and it should be of such a length as to make allowance for the retraction which takes place in it during the stage of suppuration.

"In order to secure the flap in its place while the points of suture are being placed, a thread is passed through its upper edge, and a catheter being introduced through the urethra and fistula into the vagina, the thread is passed through the eyes of the catheter, and is thus drawn out and given to be held to an assistant. 'I then introduce,' says M. Jobert, 'my finger along the flap, sliding over it a curved needle, fixed in the *porte-aiguille* used in the operation for staphyloraphy, or I direct it solely with

the hand. At one stroke the angle of the flap and the edge of the fistula are transfixed, and the needle, armed with a ligature, is withdrawn by means of a pair of dressing forceps. The same is done with the opposite angle. As soon as the points of suture are placed, they should be tied at once, to secure perfect contact. The threads are secured externally; and they come away from the tenth to the fourteenth day.*

"The next thing is to prevent the accumulation of urine in the bladder, and to secure for it a free and constant flow. This can only be effected by placing and keeping in the urethra a catheter of full size. The thread first employed should be passed down this catheter, as the ulceration it might occasion in the urethra will thus be prevented. The patient is placed in the horizontal position, and strict rest is enjoined.

"The period for the division of the flap must, of course, depend on the sufficient vitality and adhesion of its upper portion, as well as the patient's state of health. The safest course is, not to be in a hurry. M. Jobert does not divide it till the thirtieth or fortieth day; and even this may be premature. In making the division, due allowance must be made for the further retraction which will take place; it should not be divided higher up than one-half of its entire length. The external wound resulting from the transplantation, may be treated by adhesive straps or sutures; but care should be taken that no pressure be made at the lower part of the wound, that might interfere with the due supply of blood to the pedicle of the flap.

"M. Jobert thus describes the consecutive phenomena observed by him: 'As soon as the parts are brought into contact, an exudation of blood takes place in the bladder, which is voided by the catheter; the same oozing occurs also in the vagina. The wounded surface of the flap soon becomes covered with lymph; the urine becomes turbid, owing to the pus given out from the upper part of the flap; and this continues for an indefinite period, or until the upper part of the flap contracting, it becomes leveled with the surface of the bladder. I have seen it persist for twenty-five days.

"'The section of the pedicle gives rise to more or less hemorrhage and both ends of the flap soon retract. The transplanted portion, now living in its new situation, is liable, like other tissues, to various diseases; and hence it inflames, not only from the slightest contact with the urine, but even by the effects of the incision; and hence, when red and swollen, it is observed to extend out of the vagina. In this state it is engorged; suppuration soon takes place; and as this diminishes, it retracts within the vagina. Thus I have seen the flap, when divided, retract, to come forth again during the inflammatory stage, and again retract to such a degree, as not to be seen without expanding the labia, and depressing the posterior commissure.

"'It is worthy of remark, that the flap, though enjoying life, no longer possesses sensibility, all communication with the great nervous centres being cut off.'""*

Process of Velpeau.—This consists in seizing with a double

hook the posterior wall of the vagina, opposite the fistula, pushing the wall forwards by a finger introduced into the rectum, and raising up with the bistoury a bridge, an inch to an inch and a half long, from the floor of the vagina, without penetrating into the rectum. The edges of the fistula are then made raw and closed by sutures, which are made to pass, before they are tied, under the bridge, so as to elevate the arched or bridge-shaped flap, and cause it to project into the bladder. This process has failed, however, in its application upon the living subject.

Process of Leroy. (Pl. LXXI. figs. 7, 8.)—In place of the processes of Jobert and Velpeau, which he looks upon as little more than mere speculations, this surgeon has *proposed* the following. To raise a flap from the posterior wall of the vagina, as shown in fig. 7, penetrating only with the knife into the cellular space between the vagina and rectum, and stopping where the point of union between these passages becomes more intimate at the recto-vaginal septum. A short thick flap may thus be obtained, which is to be applied by its raw surface to the edges of the fistula, which should be made raw and bleeding. The flap is to be fastened by a double quilled suture, as shown in fig. 8.

The author attempted, a few years since, to close an opening into the lower fundus of the bladder which would readily admit the ends of two fingers, by passing one tenaculum transversely through the opposite margins of the fissure, and another through its front and back margins at right angles to this, subsequently throwing a ligature under the instruments, and tying it moderately tight, in order to purse up the surrounding parts and close the opening. The case was not successful in consequence of the slipping of the ligature too early. But where the opening is but of medium size, provided the edges were first made raw with the knife or by the action of lunar caustic, the author is disposed to think that this process would present a fair prospect of success.

Despairing of success in cases of large fistulæ by any of the processes known, M. Vidal has proposed to excise the mucous membrane at the anterior orifice of the vagina, and cause the surfaces to unite by the application of the quilled suture, so as to leave but a small outlet for the urine, and turn the vagina into a common urinary pouch, from which the urine can only escape by the urethra.

As there are but too many cases in which all methods of cure fail, it becomes necessary to devise some measures to palliate the inconvenience arising from the constant flow of urine. Leroy points out a mode of tamponing the vagina with caoutchouc in leaves or in paste—a substance which is elastic and unalterable, and, as he says, freer from the objections which to this day have rendered all permanent plugging of the vagina nearly impracticable.

Mr. Barnes, of Exeter, (Eng.,) employs an elongated caoutchouc bottle, which, when placed in the vagina, presents an opening corresponding to the fissure. The author has, however, had better success, with a sort of boot-shaped silver or silver-gilt trough, devised by M. Feburier, of Paris, which, when accurately fitted to the vulva, is easily held in position, and effectually prevents the escape of urine by any other channel.

* *Cyclopedia of Practical Surgery*: London, July, 1842.

PART FOURTH.

PLASTIC AND SUBCUTANEOUS OPERATIONS.

UNDER THIS GENERAL HEAD ARE CONSIDERED: 1. THE SUBJECT OF PLASTIC OPERATIONS, AS APPLIED TO THE CURE OF DEFORMITIES ARISING FROM LOSS OF SUBSTANCE; AND, 2. THAT OF THE SUBCUTANEOUS DIVISION OF MUSCLES, TENDONS AND FASCIÆ, FOR THE DISTORTIONS WHICH ARISE FROM THE RETRACTION OR SHORTENING OF THESE PARTS.

I. PLASTIC OPERATIONS.

PLASTIC surgery has for its object the restoration of parts that through accident or disease have been partially or altogether lost, by the transplantation of a portion of healthy integument. The birth-place of this branch of science appears to have been in India, where the reconstruction of the nose with a flap of integument taken from the forehead—too often rendered necessary by the barbarous modes of punishment in vogue among the orientals—has been practised from time immemorial, by certain low caste priests, who derived their origin from the Brahmins. From some remarks of Galen, it would appear that the making of noses was practised by the priesthood of Egypt, though of their method, which was kept secret, nothing is known. About the middle of the fifteenth century another form of plastic operation was brought into vogue by some Italian surgeons, the most distinguished and successful of whom was Tagliacotius, Professor of Medicine and Surgery at Bologna, whose principles and mode of practice have been handed down in his *Chirurgia Curtorum per Insitionum*.* This received the name of the Italian or Tagliacotian method, and differed from the Indian, inasmuch as the integument from which the nose was made was borrowed from over the biceps muscle of the left arm. After enjoying high favour for a considerable period, this Italian method sunk into disesteem, and Tagliacotius became a subject of ridicule to Van Helmont and Butler;—silver, wooden, and waxen noses being resorted to, to hide a deformity which the surgeons of the sixteenth and seventeenth centuries lacked the skill or the enterprise to relieve by a plastic operation.

During the war with Tippoo Saib, in 1793, the attention of the British surgeons was strongly attracted by the skill exhibited by the Indian priests in the reparation of the nose, and their process,

* A copy of this admirable work is to be found in the Loganian Library of this city.

under the name of the *Indian method*, was introduced into Europe by Linn and Carpue, of London, who operated themselves in 1813 and 1814. In the latter year, Græfe, of Berlin, revived the process of Tagliacotius with some modifications, and the operation thus modified received the name of the *German Method*.

Some ingenious modifications of the plastic art were introduced by the surgeons of France, consisting mainly in the restoration of parts partially lost by the raising or sliding of flaps from the injured organ itself or from the neighbouring structures, which has received the name of the *French method*.

Many of the surgeons of Europe, and some of those of this country, have employed these various processes with distinguished success. But to Dieffenbach the credit is due of having generalized and simplified their application, and especially that of the Indian method, which he has clearly shown to possess such advantages over the rest, that these, except in cases of smaller deficiencies, are seldom now employed.

For practical purposes, all plastic operations may be noticed under two divisions—where the integument is brought from a distant part—and, where it is derived from the structures adjacent.

First class.—This comprises operations for the restoration of the nose and lips in which the integument is brought either from the arm after the Italian or Tagliacotian method, from the forearm as practised by Græfe, Delpèch, and Dieffenbach, or from the back or palm of the hand, as has been done by Roux and Labat. The two latter modifications have been devised for the purpose of rendering the necessary confinement of the arm to the defective part less painful and fatiguing; the flap in all these cases being left adherent to the arm, till union had taken place at its other end with the part to which it had been attached by suture. In several instances, a portion of integument has been entirely detached from the arm or thigh, and at once applied on the surface of the defective organ, the edges of the latter having been

previously freshened with the knife. By this means small breaches of surface have been filled up by Dr. John Mason Warren, of Boston, and others, though it generally failed in the practice of Græfe and Büniger, who made frequent trial of it. This practice is founded upon the fact, that parts completely severed by accident from the body have, after many minutes or even half an hour had elapsed, and they had become perfectly pale and bloodless, occasionally been found still to retain a sufficient degree of vitality to accept of union after nice adjustment to the organ from whence they had been removed. It has been successful in the hands of the author where the lobe of the left ear had been torn completely off.

Second class.—Of the mode of operation, in which the flap is taken from the immediate neighbourhood of the part to be supplied, there are many varieties.

1. Raising the flap and twisting it upon its pedicle as in *rhinoplasty*, after the Indian method.

2. *Rotation of lamina without twisting.* This consists in raising a flap, the root or pedicle of which is left attached at a point adjoining the breach to be filled up. An incision is first made from what is to be the outer side of the pedicle, carried in such a direction as to circumscribe a flap of the proper form, and terminating again in the breach at the opposite side of the pedicle. The flap is then to be raised by dissection, rotated upon its root, and fixed by suture to the raw margin of the defective part. After union the pedicle in general does not require to be divided. Mr. Liston has applied this process to the restoration of one of the alæ of the nose; Dieffenbach and Von Ammon to the reconstruction of the eyelids; Jobert and Velpeau to the closure of vesico-vaginal fistulæ; Professor Mütter to the filling up of the denuded surface left by the division of cicatrices, &c. &c.

3. *Simple sliding of the flap.* *Glissement du lambeau.*—The flap to be raised forms, by its free edge, one of the margins of the solution of continuity to be filled up. It is to be dissected back from the breach sufficiently far to enable the operator to stretch it, without rotation or twisting, in order to cover the place upon which it is to be applied. It has been frequently employed in replacing lost portions of the alæ of the nose, and in repairing deficiencies of the lips and eyelids. It is a favourite method with the French surgeons, and has recently been strongly eulogized by M. Serre, of Montpellier, but is in fact little more than the old operation of Celsus, who, in addition, practised a semicircular incision through the skin, at some distance beyond the pedicle, so as to allow the flap to yield the more readily to the traction. A modification of this has been made by Mr. T. Wharton Jones, for shortening and ectropion of the upper eyelid, as described at page 143.

4. *By reflection of the flap.* The flap is to be raised from a surface near to the point on which it is to be applied, and carried by simple reflection to the defective part, upon the margins of which it is to be affixed by suture. In this way fissure through the hard palate, complicated with hare-lip, has been closed by Sanson; a flap being separated from one margin of the divided lip, and bent in upon the fissure. The column of the nose has been restored by separating a vertical flap from the whole thickness of the upper lip, and reflecting it upwards to the apex of the nose: the mucous membrane of the reflected flap becoming external, and gradually taking on the appearance of skin. Where the lip was short, Dieffenbach

has allowed its mucous membrane to remain undivided for the growth of granulations.

5. *By demi-rotation and traction.* The flap is to be cut up some distance above or below the defective part, and partly rotated and partly stretched, so as to be made to fill up the vacancy. In this way deficiencies of the lips, lids, palate, &c., have been supplied by various surgeons. In some cases, the flap consists of the skin and subcutaneous tissue, sometimes of mucous membrane only, and sometimes, as where the entire lower lip is to be supplied, of the whole thickness of the cheeks.

6. *By rolling of the flap.* An elongated rectangular portion of integument is to be cut up and rolled upon its cutaneous surface in order to form a plug, and then introduced so as to make a solid closure of openings which are rounded, and not of great size, the edges of which have been first shaved off. Velpeau has applied this plan to the cure of fistulæ left after the operation of tracheotomy; Sanson and others to artificial anus; Jamieson to the radical cure of hernia after operation.

7. *By successive migration of lamina.* This is a modification of the method of Tagliacotius. A flap is raised from a remote part, and brought by successive graftings and transplantations to the vacancy to be filled up. This has been employed by Roux, in supplying lost portions of the cheeks. Prof. Mütter and others have also employed with success this plan of the migration of lamina. But it has not in general proved in my hands a satisfactory process, as it is attended with much suffering to the patient, some difficulty on the part of the operator, and great liability to failure from sphacelation of the retransplanted flap.

8. *By bridge-like elevation of the flap.* This consists in raising two elongated flaps, one on each side of the preternatural orifice; the two ends of each flap are to be left adherent. The flaps are then to be dissected underneath, so that they may be slid as bridges over the opening; the proximate edges of the flaps are then to be fastened by suture. This plan has been employed by Velpeau and others, in fistulæ opening into the cavities of the mouth, vagina and rectum, and by Dieffenbach in the cure of urethral fistula in the male. An ingenious modification of this process has been made by Dr. Mettauer of Virginia, and has been successfully employed both by him and Professor Mütter in the closure of small openings in the palate. It consists simply, in addition to the operation as above described, of the insertion of some soft substance, as a roll of buckskin, into the new sulcus formed on each side of the flaps, so as to raise a growth of granulations from its bottom, and sustain the flaps in their new position.

In the above classification is found displayed all, or nearly all, of the *principles* which have been variously employed in the cure of deformities by plastic surgery. It is necessary that the operator should be familiar with the resources of this department of the art, though there can exist, in general, no prescriptive plan of treatment. The deformities requiring operations of this class are necessarily so dissimilar in different cases, that every new one becomes a separate subject of study to the surgeon, and opens a fresh field for the exercise of his ingenuity in restoring the lost or deformed parts, with the best success and the least injury to the neighbouring tissues.

General rules can therefore only be given for the application of the various principles of plastic operations above detailed, since,

from the limits of this work, but little room is afforded for the description of individual cases.*

RHINOPLASTY.

This term is applied not only to the reconstruction of a nose entire, but to the restoration of parts of the organ—the alæ, the septum, or the back. The former may be accomplished by the Indian or Italian methods, or the modification introduced by Græfe—the latter by the Indian or French, according to the greater or less extent of the deformity.

Indian method.—Reconstruction of the entire nose.

This method—in which, as before observed, the new nose is formed by taking a flap from the forehead—is, in the opinion of the author, always to be preferred in the reconstruction of the nose when a large part is wanting, provided the frontal integuments be healthy and somewhat movable, and the forehead itself not so low as to render it impossible to raise the flap without cutting the

* Various terms have been applied to this department of the art, but the author believes the name of Plastic Surgery, (from *πλασσω*, to mould or model,) will be found the most simple and appropriate. Using this as the generic term, we will have then *Rhinoplasty* for the nose, *Cheiloplasty* for the lips, etc. etc. M. Blandin has employed the term *Autoplasty*; M. Velpeau, *Anaplasty*; and several of the German writers *Morioplasty*, in the same generic sense in which the words *Plastic Surgery* have been used by Zeis and by the author of this work.

greater portion of it from the hairy scalp. It will be found particularly appropriate in cases where the nasal bones have been destroyed, it being in fact the only process which enables us, under such circumstances, to give the new organ sufficient firmness at its root, to retain its natural elevated position. Youth, old age, any impaired state of the general health, or habitual proneness to erysipelas, are to be viewed as counter-indications to the operation.

Before proceeding to the operation, it will be necessary to mark out upon the forehead a flap of the proper size and shape for the case in question. A model may be fitted on the face out of paper or leather, and then outlined upon the forehead with ink or lunar caustic. The plan which the author prefers, is to cut out a second model in adhesive plaster, after the first has been properly shaped, and apply it, with the apex between the eyebrows, upon the forehead either perpendicularly, or, if the forehead be low, in an oblique direction, so as to avoid as much as possible cutting up into the region of the scalp. The shape of the pattern which will be found most appropriate is seen at Plate LXXII. fig. 4; but the shape of the flap is of less importance than the cutting it of sufficient magnitude, as it changes much by the concentric contraction which occurs during the process of cicatrization. It should be at least a quarter or a third larger than the exact model of the new nose required, to allow of the shrinking which necessarily follows.

Dieffenbach has in some instances raised a flap of an oval shape, cutting out the septum, after the flap has been turned down and secured, by two parallel incisions with the scissors at its lower

PLATE LXXII.—PLASTIC OPERATIONS.

CHEILOPLASTY. RHINOPLASTY.

(Processes of the Author.)

Fig. 1.—Representation of a patient, before the operation and with the mouth closed, who had lost the entire upper lip, all the soft parts of the nose, the septum narium, and the turbinated bones.

Figs. 2, 3.—*Cheiloplastic operation.*—In fig. 2 is given an accurate view of the face of this patient, with the chin depressed. The mouth, from the entire destruction of the upper lip and a portion of the lower, was drawn by the cicatrization into a rigid narrow orifice, surrounded with a cicatrized border. This was first enlarged by extending the commissures laterally, by the *stomatoplastic* process of Dieffenbach for atresia oris, described at page. 243. The black lines upon the cheeks represent the outlines of the flaps with which the upper lip was reconstructed, as shown in fig. 3.

Figs. 4, 5, 6.—*Rhinoplastic operation.*—After the new lip had become solid and firm, the nose was restored by a flap taken from the forehead. In fig. 4 the outline of the flap and new column is shown on the forehead. The dark spots represent the points at which the sutures were subsequently passed. The pedicle of the flap is placed between the brows, the incision upon one side of which is extended lower down than the other, to facilitate its twisting. By the sides of the nasal chasm are seen the two fissures cut for the reception of the edges of the flap. The spots represent the points for the insertion of the sutures corresponding with those on the flap. Two of the sutures alone are shown partly introduced, as described in the text. The wound of the forehead was closed with hare-lip sutures, so as to leave a raw surface of but small extent. The edges of the new nose were secured in the fissures by three interrupted sutures on either side, which are seen in fig. 5, tied on small rolls of adhesive plaster after the manner of Græfe. The end of the septum is also attached to the middle of the upper margin of the new lip. In fig. 6 is a lateral view of the flap after being adjusted with the sutures. The twist of the pedicle is seen over the nose.

Fig. 7.—This is an accurate representation of the face of the same patient, taken on his visit to town sixteen months after he had left the hospital, by Mr. S. Willits of this city.

Fig 1.

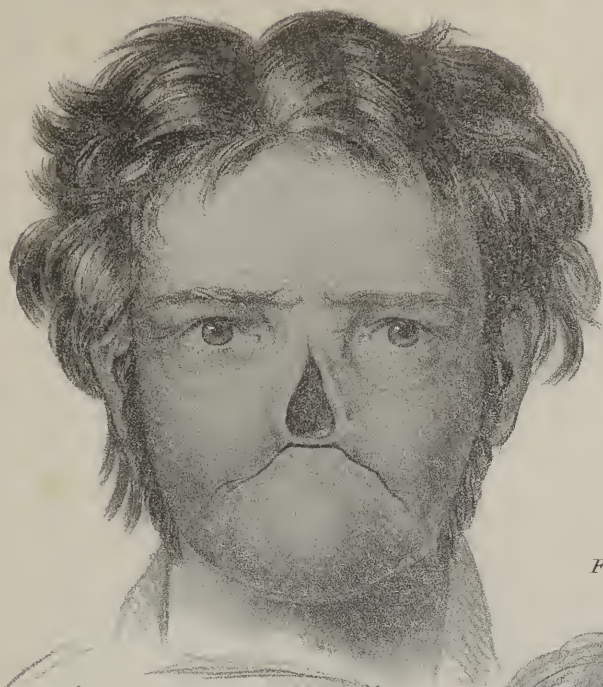


Fig 2

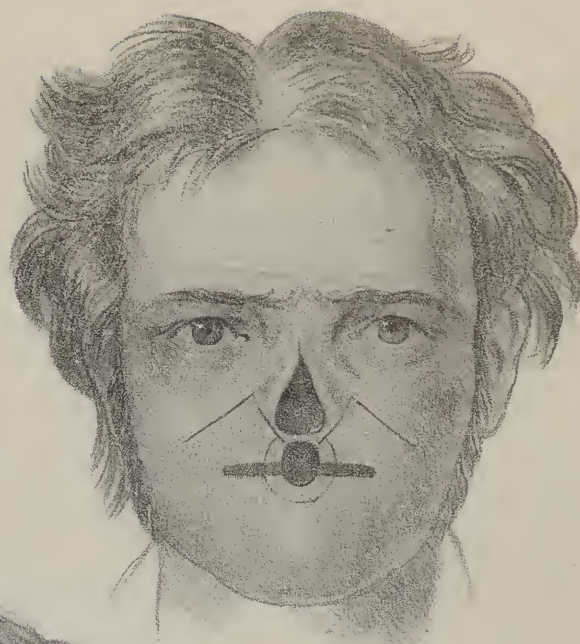


Fig 3.

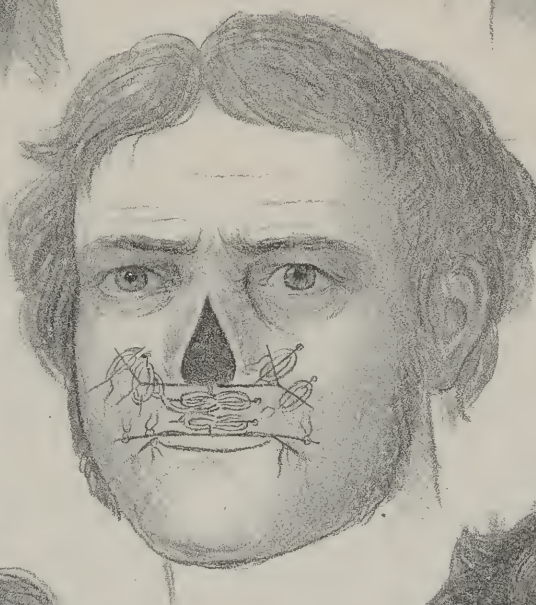


Fig 6.

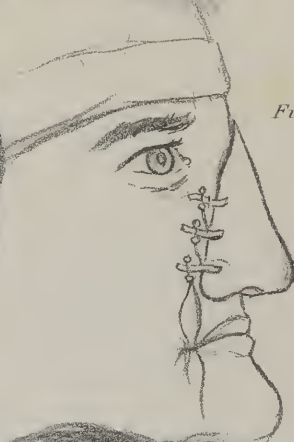


Fig 5

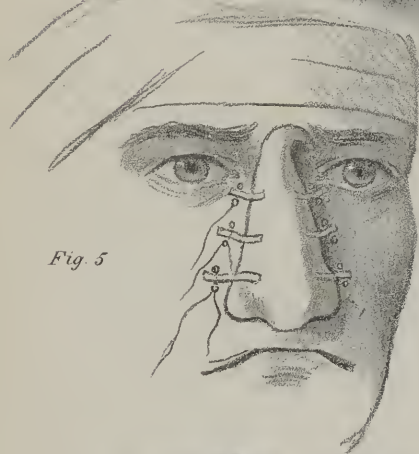


Fig 7.

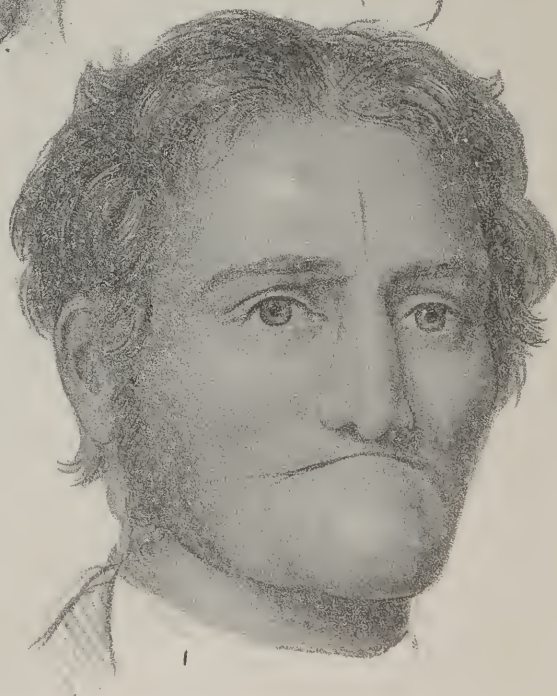
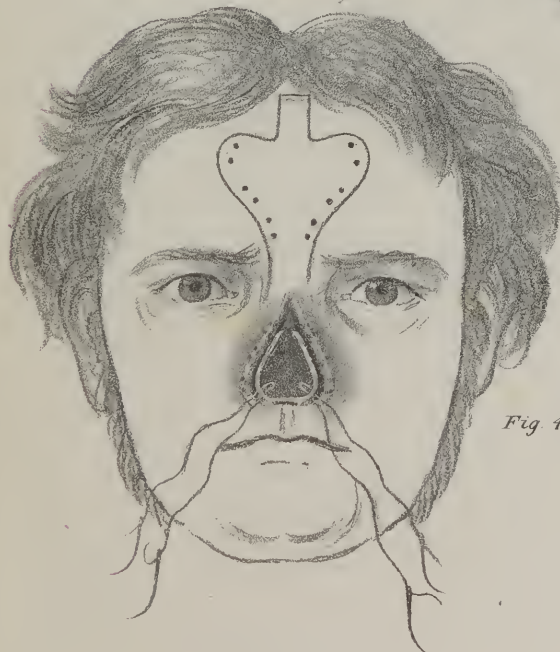


Fig 4



end. When the integuments on the forehead are thin, this mode of forming the septum will be found advisable, as it gives additional solidity to the point of the new nose. Under other circumstances, the author prefers greatly to bring down the septum from the forehead. Delpèch made the base of the flap three-pointed, in order to facilitate the closure of the wounds on the forehead; but this plan does not serve so well in giving to the new organ its proper form and proportions. Some surgeons bring down a flap from the forehead without any middle slip for the new septum or column, as in the old Indian process, and subsequently, after the new nose has been fairly united to the face, raise a column from the middle portion of the upper lip. The author has tried this process, but considers it objectionable, inasmuch as the column thus formed has a tendency, during cicatrization, to produce mutual distortions of the upper lip and the point of the nose.

After the flap is delineated on the forehead, the places for the sutures, with corresponding points on the sides of the nasal opening, should be dotted with ink or coloured varnish. The peduncle of the flap over the root of the nose should be left half an inch or five-eighths wide, as this is sufficiently narrow to allow us to rotate and loosely twist the flap, and at the same time preserve for its nourishment one or both of the angular arteries of the nose.

The incision for circumscribing the flap should be carried down between the eyebrows, as directed by Lisfranc, a little lower upon one side than the other—the one opposite to that upon which we intend to make the twist—as it gives additional facility to this manœuvre. In the usual process the pedicle, after the flap is twisted and secured, is left as a loose bridge over the skin below it, exposed on all sides to the air, and liable from this cause to shrink, so as to interrupt to more or less extent the nourishment of the flap. To obviate this danger, Liston and Dieffenbach lodge the pedicle in a groove cut in the integuments upwards from the chasm of the nose. The bulky prominence formed in this way by the adhesion of the pedicle in the groove, requires not merely cutting off and smoothing down, (as in the ordinary operation,) but to be extirpated from its bed in the after stages of the process, thus increasing the extent of the cicatrix. A better result will be obtained by the process of the author, given in the case described below, in which a small triangular flap with its base downwards is removed at the root of the nose for the attachment of the pedicle. This, with the peculiar mode of inserting the edges of the flap therein mentioned, will, judging at least from the author's success in seven cases of rhinoplasty, insure, without risk of failure, the union of the flap by first intention with the lateral grooves in which it is lodged.

Having made all necessary arrangements, the surgeon proceeds to the operation. The patient should be placed reclining upon a bed or table, with the head supported by a pillow, and the nostrils closed by lint, to prevent the blood flowing back into the cavity of the throat.

The *first step* of the operation, as usually described, consists in the paring off the edges of the stump of the nose, so as to leave a beveled raw surface for the reception of the flap. But if the nose is altogether deficient, a groove cut for it, as in the case described below, will be found decidedly preferable. A notch sufficiently wide is to be formed in the upper lip for the new column, or the lip may be drawn out as practised by Dr. J. Mason Warren, and transfixed with the bistoury at its connection with

the superior maxillary bones, so as to give room for the insertion of the end of the column. The ligatures are to be introduced round the margin of the opening.

The *second step* consists in running the scalpel rapidly round the outline of the flap, cutting to the bone, and subsequently dissecting the flap loose from the periosteum down to the root of the nose, with a few strokes of the knife. The flap is then to be turned down over the face, and the wound in the forehead closed, as far as the case will well admit, with twisted or interrupted sutures, and covered with a compress and bandage.

The *third step* consists in the twisting of the flap upon its pedicle, and attaching it by the interrupted suture to the surface prepared for it. Hare-lip pins, though preferred in many instances by Dieffenbach, will not be found, on account of the elevation of the nose above the surrounding integument, so convenient as the simple stitch. After securing the side and septum of the nose, Dieffenbach ties a tape round the septum so as to roll its margin inward, give it greater firmness, and prevent its forming adhesions with the alar margins of the new nose.

In from four to six weeks, according to the constitution of the patient, the new nose will become so well nourished at its lateral attachments, that its pedicle may be safely divided. This is accomplished by introducing a grooved director below it, and cutting it across with a probe-pointed bistoury. The end of the pedicle thus detached is then to be neatly trimmed into the form of a semicircle or triangle, and smoothly laid down in a notch cut for it in the integuments below. If the pedicle has been healed in a groove, after the manner of Liston and Dieffenbach, the protuberant part is to be raised with a pair of forceps, and detached with one sweep of the bistoury: or a lancet-shaped piece may be cut out so as to bring it down to the proper level, and the edges united by the hare-lip suture. Such are in general terms the rules laid down for this operation, by surgeons who have had most experience in this peculiar branch of surgery. The details of the operation and the modification employed by the author, will be best understood by reference to a brief description of the following case, which is reported in full in the American Journal of Medical Sciences for October, 1842. The author has selected this one of his cases, in consequence of its exemplifying the resources of this department of surgery, as not only the nose, but the upper lip and the mouth required to be reconstructed anew.

Total destruction of the upper lip, the soft parts of the nose, the septum narium, and turbinated bones. Cheiloplastic and Rhinoplastic operations. (Pl. LXXII. figs. 1 to 7.)—John Glover, the unfortunate subject of this deformity, was a native of Bridgewater in England, 53 years of age, but had the appearance of being much older. All the soft parts of the nose, and the whole of the upper lip from the commissures of the mouth up to the fossa canina of each side, as well as the septum narium and the turbinated bones were removed. The cavities of the antrum highmorianum were opened on each side by destruction of bone, so as to form a mere superficial cavity in which the ball of the thumb could be placed. The opening of the sphenoidal sinuses were distinctly seen through this cavern. The mucous membrane lining the parts seemed healthy, though covered with lymphatic exudations. The teeth, with their corresponding alveolar processes, were removed from both jaws, the upper of which, instead of its usual

arched form, presented the appearance of a thin plate. In consequence of the loss of the alveolar processes, the chin presented the excessive prominence seen occasionally in extreme old age. The free margin of the lower lip when the mouth was closed came up to the nasal cavern, and covered the edge of the upper gum, which was about two lines in thickness. The appearance of the mouth closed is seen in Plate LXXII. fig. 1, which is an accurate representation of the face taken from a drawing by Mr. Schultz. In the cicatrization which followed this extensive ulceration of the parts, the mouth had been narrowed by union of the lower lip for about half an inch from each corner to the flesh of the cheek above, the line of cicatrization being still visible. When the mouth was opened to its widest extent, it formed a rigid circular orifice three-quarters of an inch in diameter, through which the patient took his nourishment with a small spoon, and could with difficulty protrude the point of his tongue. This extensive destruction of parts took place, *according to the patient's statement*, eight years previously, in consequence of a violent contusion of the face, received from the handle of a saw, while superintending the labours of a saw-pit. He was under the care of Mr. Toogood, of Bridgewater, and after the parts had cicatrized, visited Sir Astley Cooper, for the purpose of having something done for the removal of the deformity; both of these gentlemen, however, according to the patient's statement, considered the case so hopeless as to be beyond the reach of relief by any operation. Whatever has been the cause of the disease, he was, when he presented himself to me, an object of disgusting deformity, an outcast from his family and friends, anxious to submit to any operation that might diminish his deformity, without destroying life. As his complexion was florid, his cheeks full, and his general health good, I determined to comply with his wishes, and see how much succour surgical science could afford, in a case apparently so desperate.

There were three indications to fulfil in the operation: 1st, to enlarge the mouth to its natural dimensions; 2d, to reconstruct the upper lip by flaps taken from the cheeks; and 3d, after the new lip had become solid and firm, to build a new nose with integuments reflected from the forehead.

I performed on the same day the operation for the first two indications, at the Philadelphia Hospital, before the class of the Jefferson Medical College. The mouth was widened after the manner of Dieffenbach, already described under the head of atresia oris, page 243, and which may be well understood by reference to Plate LXXII. fig. 2. The next step was to restore the lip. The process by which this was accomplished is shown at Plate LXXII. figs. 2, 3. I first made raw the free surface of the gum with a bistoury; then ran an incision from the point where the gum was covered by integuments obliquely upwards and outwards for an inch and a quarter. From the termination of this, I extended another cut for about the same distance, nearly parallel with the incisions for widening the mouth, but somewhat inclined downwards. The cheeks were loosened from the gum and malar bone by some incisions on the side of the mouth; the flap of skin and subcutaneous fatty matter was next raised from the surface of the muscles with the knife, beginning the dissection at the angle next the nose. Several branches of the infra-orbital and facial arteries were divided, to which torsion was applied. The flaps of the two sides were then drawn downwards and forwards over the raw surface of the gum, and fastened together with the hare-lip suture. The inner edge of the flaps, which had been purposely cut sloping outwards, when thus rotated downwards, came accurately together at the median line. As these were stretched forwards, the general integuments of the cheeks advanced, so as to diminish to a great extent the space from which the flaps were removed. The edges of this space were closed with pins, so

PLATE LXXIII.—PLASTIC OPERATIONS.

RHINOPLASTY. FLAPS TAKEN FROM THE CHEEKS. (*Process of the Author.*)

- Fig. 1.*—Representation of a case operated on by the author for the removal of a deformity caused by the destruction of the hard palate, the septum narium, and all the soft parts of the nose, with the exception of the tip and column which were distorted by the cicatrization and fastened to the lower end of the ossa nasi.
- Fig. 2.*—This drawing shows the gap left after the dissection of the cicatrix, and the traction of the point of the nose downwards, as well as the outline of the flaps cut up from the cheeks to fill the breach.
- Fig. 3.*—The flaps are here seen applied filling up the breach, and fastened in place by many hare-lip sutures. The wounds left upon the cheek are closed by similar means.
- Fig. 4.*—Is a profile view of the reconstructed nose ten months after the operation. The black lines are intended to represent the dimensions of the space filled up.

RESTORATION OF ONE-HALF THE NOSE AND A PART OF THE CHEEK; FLAP TAKEN FROM THE FOREHEAD.

- Fig. 5.*—The parts had been destroyed by lupus, and the extension of the disease rendered it necessary for the author to remove not only the margins of the opening which had laid bare the nasal cavity and removed the septum, but also to take away a portion of the cheek embracing the infra-orbitary nerve. The nerve, which was diseased, was excised from the bony canal, and was found enlarged so as to present the appearance of a ganglion. The flap is seen dissected up from the forehead, and partly twisted.
- Fig. 6.*—This drawing shows the appearance of the flap when adjusted so as to close the breach.

Fig 1



Fig 4

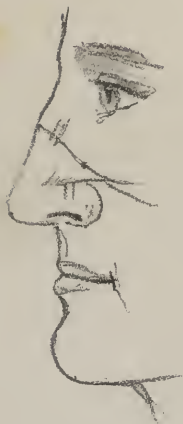


Fig 3



Fig 2.

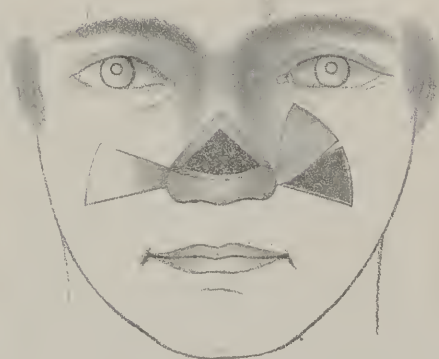


Fig. 6.

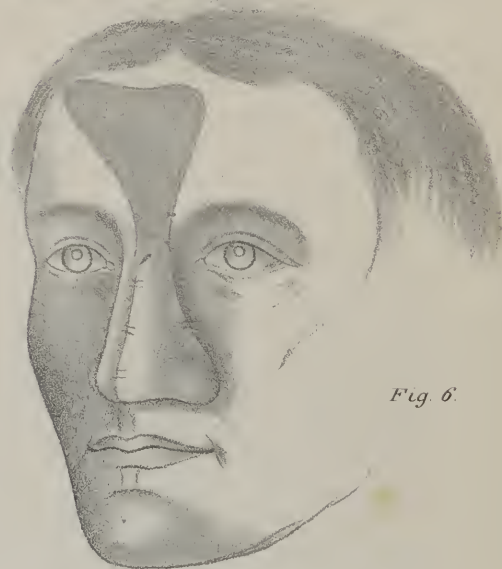


Fig. 5

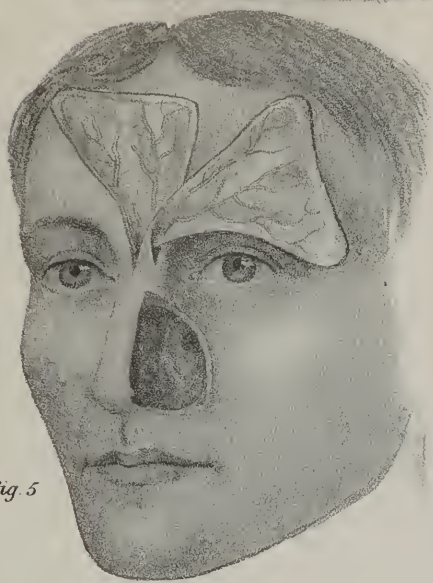


Fig. 8

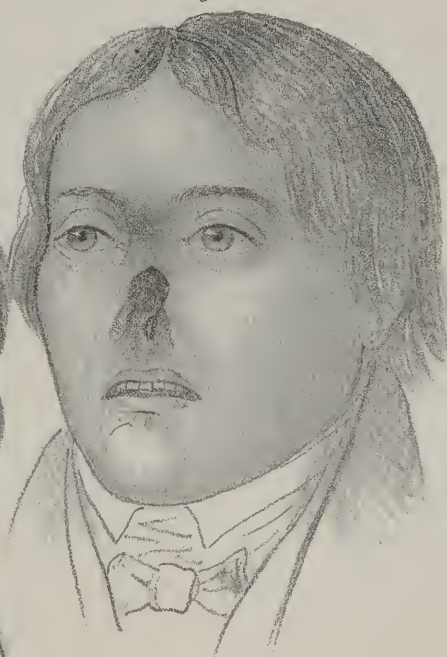


Fig 7.

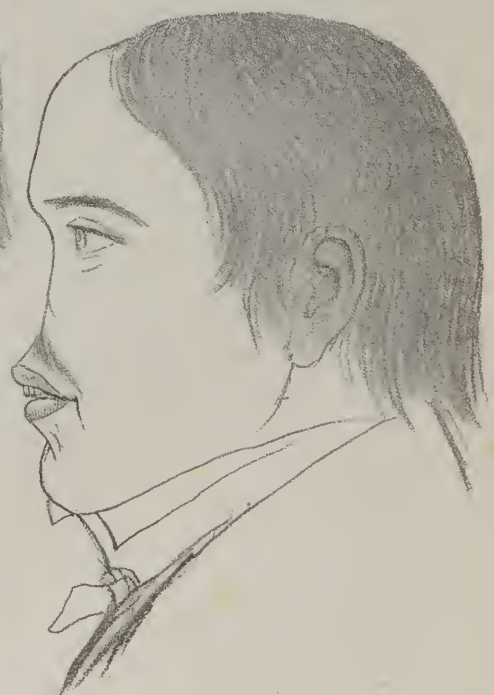
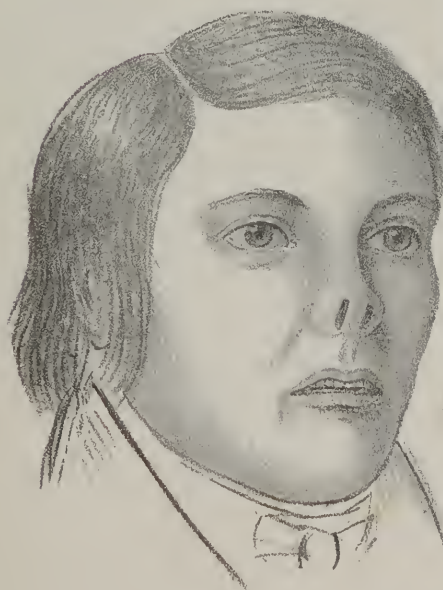


Fig 9



placed as not to give rise to ectropion by drawing on the lower eyelid. The integument by the side of the nasal cavern was loosened with the knife on each side, and fastened with a cross-pin, so as to give a cuticular covering to the raw margin of the new upper lip. The face was covered with lint, directed to be kept constantly wet with a solution of lead-water and laudanum.

The two operations and the dressing occupied about an hour and a quarter, but were borne by the patient without a murmur.

Two months subsequent to this operation, the new lip being then firm, and solidly united with the gum, I proceeded to the restoration of the nose, assisted by Drs. J. K. Mitchell, Peace, Bournonville, and in presence of the hospital class. The hair was shaved from the temples and forehead, the nasal opening stopped with lint to keep the blood from entering and passing down the throat, and the patient placed upon the operating table, with his head supported by a pillow. A flap was raised from the forehead of the shape indicated in fig. 4, which had been previously traced with lunar caustic. The skin was divided at a single sweep with the blade of the knife inclined outwards so as to cut a beveled edge. The apex, which was about five-eighths of an inch wide, rested between the eyebrows, and the tongue-like portion for the column stretched up into the scalp. The flap was near three inches wide at its base, and was cut up larger than seemed necessary, in order to make allowance for its unavoidable retraction. Pressure was made on the temporal arteries, during its detachment, which occupied but a few moments. A small strabismus hook I found useful in raising the column at the commencement of the dissection. The flap, after being dissected up, was turned down on the left side, wrapped in linen, and the wound in the forehead drawn up with four hare-lip sutures. The large wound of the forehead was thus narrowed down at once by closing up the angles, so as to leave a raw surface in the centre not much larger than a quarter dollar; its surface was dressed with raw lint; over which a couple of adhesive straps, simple dressings of lint spread with cerate, and a roller were applied. A narrow fissure existed at the lower part of the wound after the application of the pins. I next made raw the surface of the new lip and gums, and carried an incision down to the bone just at the outer side of the margin of the nasal chasm. The integuments were then dissected each way from this incision, so as to leave a groove between them for the lodgment of the edges of the new nose. The inner margin was raised up so as to form a vertical wall, for the purpose of bringing the raw surface into contact with the raw side of the flap, and thus give an increased probability to the adhesion of the graft; to render the union still more certain, the triangular piece of skin enclosed by the two grooves at the end of the *ossa nasi*, was cut away, and the cuticle pared off from the edges of the flap with which the new nose was to be formed. Three waxed silken ligatures, with a needle at each end, were placed at each side, by passing one needle from without inwards through the inner wall of the groove, and again in the opposite direction about an eighth of an inch above the first puncture, so as to leave the two needles of each ligature resting on the cheek, with a loop through the inner wall of the groove, as seen in fig. 4. The flap from the forehead was then rotated to the right upon its root, the incision being carried down a little lowest on the left side, so as to allow of the turn being made without putting such

tension on the pedicle as to interfere with the distribution of blood into the flap. There was but little oozing from the flap, although it retained its natural colour. The two needles at the end of each ligature were then passed through the margin of the flap from within outwards, and again through the integuments on the outer side of the groove, so that when they were drawn tight they necessarily sunk the edge of the flap to the bottom of the groove, and brought four raw surfaces into contact.* The dots on the flap (fig. 4), represent the points through which the threads of each ligature were passed, after the flap was twisted round. The threads were tied over small rolls of adhesive plaster after the manner of Græfe and Labat, so as not to strangle the parts included in the loop. The middle of the three ligatures were placed a little farthest from the free margin, and knotted over a roll of plaster three-quarters of an inch long, which rested against the flap, and sunk it in so as to support the side of the nose, and give the depression naturally existing above the oval cartilage. The left margin of the new nose was secured before the right, in order to give greater facility in the nice adjustment of the ligatures. A small ligature was then passed through each edge of the integuments of the new column near its root, and tied upon one side, so as to give a rounded form to the column, by bringing the two lateral surfaces together posteriorly, as well as prevent its adhering to the margins of the new *alæ*. The cuticle was removed from the lower end of the column by a beveled cut; the column was then pushed in upon the gum, and secured upon the new upper lip by two pins, one of which was semicircular. A piece of lint dipped in oil, was passed on each side up the new nostril; another was laid on each side of the nose over the ligatures. Lint spread with cerate, was placed upon the sides of the nose and over the wound between the eyebrows—the whole secured with a split adhesive strap brought down from the forehead. The patient was put to bed, directed to take ten drops acet. opii every three hours till he should be composed to sleep; to have lead-water and laudanum constantly applied over the dressings; to live on acidulated gruel, and to be watched night and day, lest he should, by some involuntary motion of the hand, disturb the attachment of the newly grafted nose.

The operation and dressing occupied but little more than an hour, and was borne by the patient almost without a complaint.† Not more than six ounces of blood were lost. Some little delay occurred during the latter part of the operation, by the blood flowing into the throat, causing the patient to rise up and spit. In consequence of the peculiar form of the flap, and the new method of fastening in a groove adopted in this case, the nose presented, immediately after the operation, much of the natural appearance of the organ, and was held so firm in its place as to be incapable of being moved by the respiratory efforts, as described to be usually the case when the ordinary form of fastening is employed, in which the beveled edge of the flap is merely secured in contact with the beveled edge of the nostril. Figs. 5 and 6, for which I am indebted to the pencil of Mr. Neagle, represent

* This process of the author for attaching the graft has been successfully employed by Dr. W. Poyntell Johnson, of this city, and Professor Baxley, of Baltimore—union taking place in each of these instances by first intention.

† In the last but one of his seven rhinoplastic operations, (which was performed in 1844, by the author, before the class of the Jefferson Medical College,) the whole operation and dressing were completed in little less than half an hour.

very accurately the front and profile views of the nose, immediately after its formation. An hour subsequently to the operation, an oozing of arterial blood took place at the left side of the pedicle, where the angular artery, or a branch of it had been divided; a little scraped lint, a compress and bandage, with cold lead-water and laudanum applications, speedily arrested the discharge. The patient slept pretty well the following night. The succeeding day he suffered with headache, which was relieved by a mercurial cathartic.

The after treatment of the case was not attended with anything very peculiar. The flap retained its sensibility and colour, and on the fourth day was found united throughout its whole insertion in the grooves by first intention, and after the second dressing, preserved its position so perfectly as to require no stuffing of the cavity. To keep the nostrils from being occluded by a tendency to union between the sides of the ala and the septum, sections of a large sized gum catheter were worn for a considerable period in either orifice.* The wound of the forehead healed up under the ordinary means of treatment, leaving only a small cicatrix, almost entirely hidden by the drooping hair of the front part of the head.

Having allowed five weeks† to elapse for the process of shrinking and contraction to become in a great measure arrested, the pedicle, which contained the angular arteries, was divided. A director for this purpose was passed between it and the bridge of the nose, where there was, of course, no adhesion of parts, and the pedicle divided from the left to the right side obliquely upwards. A loose triangular lamina, which shortened itself considerably after division, was thus left attached to the new nose. The bleeding from the angular arteries was stopped by pinching with the forceps. The triangular piece was diminished by paring off the sides, and shaving away a portion of its inner surface; it was then smoothly fitted down over the root of the ossa nasi into a cavity, made by the excision of a portion of the subjacent integument for that purpose. A few stitches of the interrupted suture and a compress and bandage completed the dressing. On the third day the sutures were removed. Some suppuration had taken place along the left line of junction, and there was considerable tumefaction

* When sufficient attention is not given in this respect, it may be necessary subsequently to pare away the contracted margin so as to restore the opening of the nostrils. To prevent this tendency to closure, Labat and Pinel-Grandchamp have advised the beveling off of the free margins of the alæ, turning in the thin portion of skin, and using it like a strip of mucous membrane, to hem the borders, a process which is said to have answered well in practice.

† Dr. Wm. Keith, (*Lond. and Edin. Monthly Journ. of Med. for 1844.*) believing that the subsequent shrinking of the new nose depended upon the paucity of its supply of blood, has recommended that the pedicle of the flap should be left undivided. For this purpose he makes raw, previous to the operation, the skin of the root of the nose and the under surface of the slip, where they are opposed to each other, by a strip of adhesive plaster. The parts, he states, adhere very readily, and the usual after-contraction in the cicatrix flattens down the slip till it is little visible. The shrinking and contraction of the new nose may possibly be greater where the pedicle is left only "a third of an inch in breadth," but I have been disposed to look upon it mainly as the consequence of the cicatrization of its under surface, which can only be met by making the new organ of a size sufficiently great to allow of its reduction by this means. M. Serre has proposed to meet this difficulty by making the flap very large, and doubling it so as to leave no raw surface exposed for cicatrization, the doubled cutaneous surface being presented inwards towards the nostrils. This measure of M. Serre might probably give a good result, but in most instances, where a large part of the organ is to be supplied, it would require the detachment of too great a portion of the neighbouring integuments.

of both canthi. By the twelfth day, the union was smooth and perfect.

Fig. 7 is a faithful representation of the patient's face, taken from a drawing made sixteen months after his leaving the hospital. The nose was of so good a shape and so much in keeping with the other parts of the face, as not to attract any particular observation from strangers. With the exception of a slight drooping at the apex, and a sort of abruptness at its line of connection with the cheeks, it could scarcely be distinguished from a natural organ. Seldom, perhaps, has a plastic operation been undertaken under more disadvantageous circumstances, and the supplying of three such important features in one face, as the mouth, nose, and upper lip, could hardly fail to be appreciated at its just value, by any one who has witnessed so horrible a mutilation.

Second Indian method. (*Process of the Author.*)—In cases where all the middle portion of the nose has been destroyed, and the tip and margin of the nostrils, though drawn upward, and sunken by the cicatrization of the ulcer, have not materially suffered in their structure, the nose may with great advantage be repaired with flaps taken from the cheeks, by what may be denominated the *second Indian method*.

I employed this process with gratifying success in the case of a young man, reported at length in the *Amer. Journ. of Med. Sciences* for 1842. A great portion of the hard palate, the sockets of all the upper incisor teeth, all the cartilaginous portion of the septum narium, the inferior turbinated bones, the whole of the superior lateral cartilages of the nose, and a considerable part of the inferior oval cartilages, as well as the integuments of the nose, had been destroyed by scrofulous ulceration. An open cavity was thus formed three-quarters of an inch in extent, between the ends of the ossa nasi and the tip of the nose, which, with the columni nasi, and the anterior margin of the nostrils, were uninjured. When the cicatrization of the ulcer took place, the tip of the inferior remnant of the nose was drawn up for half an inch, and at the same time sunk inwards nearly to a level with the cheek. The destruction of the alæ having been greatest on the left side, the margin of the left nostril was retracted most. The drawing (Pl. LXXIII. fig. 1.) is a faithful representation of the deformity as it appeared at the time of the operation. The soft palate was uninjured. The opening in the hard palate extended from the upper lip backward for an inch and a quarter, and at its widest part was about three-quarters of an inch broad. The gums uniting across, had formed a fleshy band in front of this opening, and the upper lip, which had been loosened from its former attachments by the ulceration, was flattened and depressed. Reflecting upon the case, it appeared to me that as the margin of the nostrils and the columna were tolerably perfect, and merely drawn out of shape by the cicatrization, they might be loosened by an incision, and drawn down so as to be useful in rebuilding the nose; filling up the gap necessarily left with flaps taken from the cheeks or forehead. But in this case I preferred to take the flaps from the cheeks, as these were full and fleshy, and I believed it possible to cut the grafts in such a manner, that when twisted round to fill the opening, they would draw by their pedicle upon the loosened rim of the nostrils, and thus keep the tip of the nose tilted downwards, as well as serve to counteract the resiliency naturally to be expected in parts which had long been confined in a morbid position.

I performed the operation in the Philadelphia Hospital, January 9th, 1841, before the class of the Jefferson Medical College. The patient was laid upon a table, and his head supported by pillows. I commenced by dissecting off the tegumentary covering of the depressed cicatrix just below the ossa nasi, so as to get a beveled raw surface, upon which the margins of the flaps were to rest. The end of the nose was separated from the ossa nasi, by pushing a sharp-pointed straight bistoury with the back to the cheeks across the cicatrix, and cutting outwards.

Before the tip of the nose could be drawn down to its proper position, it was found necessary to divide some adventitious adhesions within the nostrils.

The elasticity of the oval cartilage still, however, gave it a strong disposition to resume its former position. This was almost entirely overcome, by extending the incision of the cheek outwards and downwards, through the root of the oval cartilage, and by nicking the inner margin of the same with a probe-pointed bistoury introduced through the nostril of each side. A triangular flap of integuments was then marked out on each cheek just below the malar protuberances, of the shape represented in fig. 2, and of a size calculated to fill the breach; the left being the largest, as on that side there was the largest space to fill up. The outer limb of the triangle was rounded, so as to give a prominence to the ridge of the nose, when the base of the flaps should be brought to the middle line. The flaps were circumscribed by an incision through the skin, beveled inwards towards their centre, so as to furnish an oblique surface, by which they might rest upon the raw edges of the nose. They were then dissected up, with as much subcutaneous cellular tissue as could be taken, without involving the muscular fibres. Several small arteries were divided, from which the hemorrhage was stopped by torsion. The pedicle of each flap was left opposite the attachment of the oval cartilage upon the cheeks. The flaps were then twisted round so as to make that which was the lower margin on the cheek, become the upper margin on the nose, bringing them together by their bases on the middle line. They exactly filled up the open space on the nose, and the effect of the twisting was to hitch up the root of each ala, and, as had been calculated upon, keep the tip properly depressed. The flaps were now fastened to each other on the dorsum, and by their sides to the adjoining parts of the nose, with small palladium pins and twisted sutures. No stitches were used. The fragment of cartilage which was adherent to the ossa nasi, had from the contraction of its margin a disposition to curve in, and fall below the flaps. This it was found necessary to divide by a vertical cut on each side, before the pins were applied, when all the parts were brought upon a level. Before fastening the inferior margins of the flaps, the nostrils were lightly stuffed with oiled lint. The sides of the two wounds upon the cheeks were brought together by hare-lip sutures, care being taken in applying the pins, that the stress should be from below upwards towards the canthi of the eyes, and not upon the middle of the lower eyelid, which might have caused ectropion. The oblique direction of the pins at the same time prevented any distortion of the upper lip. The drawing (fig. 3) shows the appearance of the parts when the operation was terminated. The dressing was completed after the manner of Mr. Liston, by laying over the nose lint wet with warm water, and covered with oiled silk to prevent evaporation. The eyes

were also covered, and the patient directed neither to open them, nor attempt to speak. The whole process occupied an hour, and though necessarily painful, was borne well by the patient. The flaps, immediately after the dressing, were cold, blue, and insensible. They soon regained their natural colour, but their temperature did not return till four hours subsequently. The patient, after the operation, was affected with a slight rigor, which disappeared on the administration of some warm wine and water.

On the removal of the pins at the first change of dressings, complete union was found to have taken place everywhere, except at the median line, where there was some suppuration.

All the loose ligatures were removed on the 20th. Some suppuration had taken place on the front part of the flaps at their junction on the ridge of the nose. A short pin was found here, that had ulcerated through, having been overlooked. In every other part union was complete by first intention. The nose was somewhat flabby, for want of cartilaginous support, and bulged a little along the seams: the patient breathing freely through the nostrils. The ulcerated opening was closed with adhesive straps, and simple dressings applied, leaving the nose of good shape, and very passable in appearance.

When the ulcerated portion on the ridge had healed, it was found that the oversight in not removing the pin at this place had caused the ridge of the nose to be a little sunken at one point. The tip, however, still preserved its natural position. The pedicles of the flaps projected a little out upon the cheeks, and the flaps themselves rose upon the sides of the nose a little above the general level. This seemed to be the result of the traction of the cicatrix on the cheeks. This defect was removed by the following operation. I divided the pedicle transversely on a level with the cheek; cut out a V shaped piece of integument, with the point downward upon the cheek, and closed the edges with the hare-lip suture; a similar piece was removed from the new flap with the point upward upon the side of the nose, and the wound closed in like manner. This double operation was performed on both sides of the nose. Its object was to diminish the bulge of the flap, and render the junction between the nose and cheek smooth and even. To restore the natural sharpness of the ridge, and remove the sudden depression at the front part of the new structure, which gave a pug-like rising to the tip, I cut out at the same time in front of the graft a small triangular piece, the base of which was upwards and included the depressed parts. I then made raw the edges of the flaps on the ridge of the nose; dissected up the margin of the grafted pieces on either side, stretched them forward, and fastened the parts together with hare-lip pins. The pins were removed on the third day. Every step of the second operation succeeded perfectly, except the attempt to stretch the grafts on the ridge of the nose. The texture of these was so altered that it would not bear extension like a fresh piece of skin, and a small portion of the margin on each side ulcerated. Simple dressings were first applied.

In the course of a week the ulcerated edges of the flaps on the ridge of the nose, being left too high for the general level of the nose, were rounded off by being lightly touched with caustic. Stimulant ointments were subsequently applied to encourage granulation.

In this way the deformity on the ridge of the nose was entirely

removed, and the new organ was left presenting an appearance nearly natural. There was still some tendency in the roots of the new alæ to be drawn out on the cheek. In order to counteract this, I directed two pieces of sheet-zinc, moulded to the shape of the cheek and nose, to be worn fastened together with strings over the bridge, and secured with a riband round the neck. This effected the object completely, but the patient was directed to wear it for two or three months at least during the night in order to preserve the shape of the nose. The accompanying cut (fig. 4) is a profile representation of the nose ten months after the operation. In the fastening of the flaps in their new position, I followed in this case the plan of Dieffenbach, as described by Zeis—the introduction of a great number of pins close together, which were surrounded with circular ligatures and cut short. In subsequent operations, however, I have given a preference to the interrupted suture, as I have not found the nice adjustment of parts accomplished by means of the pins, to compensate for the greater irritation and liability to ulceration to which the pins give rise.

Italian or Tagliacotian Method.

The place, as before observed, chosen by Tagliacotius for the detachment of the flap, was the bicipital region of the arm, immediately below the insertion of the deltoid muscle. The process of this surgeon consisted really of several distinct operations.

1. Having made a careful calculation of the dimensions necessary for the flap, with the due allowance for subsequent shrinking, he raised the skin in a large fold with a pair of forceps devised for the purpose, and passing a bistoury through the base, loosened the fold by one sweeping cut, so that it could be raised in the form of a bridge. The more recent followers of this method prefer to make two lateral incisions, and subsequently raise the bridge by dissection under the skin, partly with the edge of the knife, and partly with the handle or the finger. A linen bandage of a breadth corresponding with the length of the incision, was then drawn under the bridge, to prevent its reuniting with the parts below, and cause it to thicken itself by a growth of granulations from its inner surface. At the end of a fortnight, or as soon as the bridge was in this way rendered sufficiently firm and resistant, and showed a tendency to cicatrize on its under face, the surgeon proceeded to detach it at one of its extremities.

2. If a nose or an upper lip was to be formed, the upper end of the bridge was severed—if the lower lip, the inferior end. If the flap was of sufficient size, this was done by a transverse cut, if not, a semilunar incision was made for the purpose of taking up an additional portion of integument. The flap thus detached at one end, was left to thicken by granulation for five or six weeks longer, before it was deemed fit for transplantation. Simple dressings during this period were applied over each raw surface, a piece of oiled card interposed between to keep them from sticking together, and the whole surrounded with a compress and roller.

3. Before transplanting the flap, the patient was fitted with a cap, and a peculiar jacket made of leather or strong drilling, to which the straps for the confinement of the arm were to be fastened. The edges of the nasal opening were then refreshed with the knife as in the Indian operation. The end of the flap was next trimmed into the proper shape, and fastened by several points

of the interrupted suture to the raw margin of the deficiency to be supplied. The nostrils were then lightly stuffed with lint, and the arm with the hand over one side of the head, firmly secured in position by the following bandages, viz: the *fascia regia*, which ran from the chest to the elbow, and thence along the forearm to the hand; the *fascia axillaris*, which began at the elbow, at which place it was attached to the preceding bandage and ran to the right temple, where it was affixed to the cap to prevent lateral motion of the head; the *fascia pectoralis*, which ran from the elbow to the opposite side of the chest; and the *fascia brachialis*, which surrounded the carpus, was attached to the fascia regia, and secured the hand upon the head. Union usually took place between the third and fifth day, when some of the sutures were removed, and the remainder a day or two later.

4. Tagliacotius did not separate the arm from the newly-formed nose, until eight days after the transplantation. Then the connection was severed with a bistoury, and the adherent part cut into shape so as to form the alæ and the septum, the latter of which was fastened by suture to the base of the upper lip.

The process of Græfe, dignified as the *German method*, is a mere modification of the preceding, by which the several protracted stages of the Tagliacotian method are reduced to one. Græfe raised a large flap from the arm, and at once applied it upon the stump of the nose. To admit of the shrinking which must necessarily, under such circumstances, take place to a great extent, the flap was cut six inches long and four inches broad. The flap was attached, and the nose held in position very much by the same means as detailed in the preceding operation. Union took place in different cases so as to allow the flap to be separated from the arm, at periods varying from four to twenty days. In an interesting and successful case recently reported by Dr. J. Mason Warren, of Boston, the union, however, was found complete and the flap severed from the arm, at the end of the third day, or seventy-two hours after the operation.* By the process of Græfe, there is however more risk of failure in the operation than by the Tagliacotian method, in which the flap by the sort of sub-inflammation to which it is subjected is rendered more thick, rigid, and vascular, and therefore preserves its position better and is less liable to fall into gangrene.

Restoration of partial losses of the Nose.

Restoration of one of the alæ.—This is usually accomplished after the French method, by raising a flap of an appropriate shape from the cheek and *gliding* it over the breach, or cutting it in such an oblique direction that it may be brought round by *demi-rotation*, and fastened by suture to the edges of the morbid opening, previously rendered raw with the knife. This is a practice which has been favourably spoken of by many of the surgeons of the present day. The author has found it to answer well where the deficiency has been but small; but where an entire ala is to be supplied, it is so difficult to overcome the continual tendency to contraction, by which the cicatrix on the cheek, aided by that of the flap itself, draws down and distorts the shape of the organ, that he has latterly in such cases resorted to the transplantation of a flap from the forehead. When along with the ala the upper lateral part of the nose is lost, there is no alternative

* Boston Medical and Surgical Journal, March 1, 1843.

but the latter process. The plan to be pursued in such cases, is in principle so much like the operations for the construction of the entire nose, that it will not need particular description. Occasionally it may be necessary to supply with the ala a portion of the cheek, as in the operation shown at Pl. LXXIII. fig. 5. In this case—that of a gentleman from the south—I was compelled, on account of a lupus that had destroyed one of the alæ, the septum and a portion of the cheek, to extirpate so much of the latter structure as to include the infra-orbital nerve, which, from having been involved in the disease, presented a ganglionic enlargement that had been for a long time the source of severe neuralgic pains. The operation proved completely successful in extinguishing the morbid affection, and closing the breach which it had made in the nose. The mode of performance will be well understood by reference to Plate LXXIII. figs. 5 and 6. When the defect is small, and the nose is at the same time sunken, as in a case of deformity following ozæna, described in the Amer. Journ. of Med. Sciences for 1842, I have succeeded to a considerable extent in restoring the organ to its proper form by cutting out an oval-shaped piece, and raising and uniting the margins with the hare-lip suture. When the deformity consists merely in the shrinking of the ala of one side, Dieffenbach has proposed to reduce the other to the same dimensions by the removal of an oval portion from its side.

For a deficiency of the margin of one ala, the same surgeon has devised a process for reducing the two to the same level, in which the object is to shorten the healthy side, and lengthen the one that is defective. This consists in splitting the back and tip of the nose through the cartilaginous septum, loosening the defective side from the nasal bone so that it may be drawn down, and taking out a piece from the opposite side and from the septum by two transverse incisions. The two halves are then to be placed upon the same level, and united along the back by hare-lip sutures.

Angular or crescent-shaped losses of substance at the margin of one of the alæ, it has been found difficult to replace by any of the ordinary processes without leaving more or less deformity. In two cases of this description, one produced by the application of caustic potash for the removal of an erectile tumour, and the other by a destructive ulceration from lupus, the author obtained the most gratifying success by the following process. Having pared off the edges of the fissure, a delicate scalpel was carried just below the skin upwards and backwards from the angle of the fissure to the nasal process of the upper maxillary bone, and then turned with its edge inwards so as to cut into the cavity of the nose, dividing the cartilage across. Another incision was then made from the junction of the stump of the ala with the upper lip, so as to divide the skin and the curved border of the alar cartilage below it, by a semicircular incision, concave downwards and outwards. The cartilaginous portion included between these two incisions was next divided from within outwards, so as to separate with the cartilage the soft parts for a little distance from the bone, but without cutting through the skin. The lower segment of the ala was now left attached by little more than the integument, and by advancing the soft structures of the cheek was readily drawn forwards to the upper raw margin of the nose, to which it was attached by suture, restoring the organ at once to its proper shape, and without leaving any obvious wound. Some

attention was required in filling the nostril with lint, in order to keep it sufficiently patulous. By this means the new margin of the nose is left cartilaginous, retaining its natural thickness and elasticity—advantages which the author has not been able to procure by any other process.

Restoration of the lobule or tip of the nose.—This is occasionally required either in consequence of the accidental destruction of the part, or by malignant ulceration. Delpêch, and in one instance Dieffenbach, supplied the loss by the detachment of a small flap with a long pedicle from the forehead. But neither this process nor the Italian answers so well, in cases of this description, as the French method of displacement. A process like the one described for the repairing of angular or crescent-shaped losses of substance in the margin of one of the alæ, will be found to answer well, the operation being performed on both sides of the nose, and the flaps separated from the bone well outwards on the cheek, so that they may be readily drawn upwards and made to meet on the middle line, where they are to be attached together by suture.

M. Serre,* in a case of cancer of the lobule, which he removed by a triangular incision, the apex of which ran well up on the back of the nose, closed the breach neatly by dissecting up the integument from the alar stump of each side, and stretching the flaps over till they could be united by suture in the middle line. To make these meet he was, however, obliged to retrench still farther the cut edges of the cartilages and a portion of the septum. In place of the deformity a vertical and linear cicatrix was alone left on the back of the nose.

Elevation of a depressed Nose.

In a case of this description, in which the bones of the nose had been destroyed by scrofulous ulceration, and the nasal integument, instead of forming its usual prominent arch, was folded inwards so as to present a tortuous, irregular furrow that gave the appearance of a death's head, Prof. Dieffenbach was successful in relieving the deformity by splitting lengthwise the sunken nose into a middle and two lateral strips, and then beveling off the inner edges of the two upper lines of junction, and the outer edges of the lateral flaps at their attachments to the cheeks, so as to be able to raise up the nose when the parts were attached together by pins, on the principles employed in the construction of an arch. This constitutes the process rather of rhinoraphy than rhinoplasty, and may be found to answer well *when the loss of substance in the nose is more apparent than real*. The author has not, however, resorted to this process, believing even if it should prove successful in immediately accomplishing the object desired, that there would be great probability of the nose sinking a second time under the slow contraction of the cicatrices.

Instances, nevertheless, occasionally occur in which the sunken nose may be raised by other means. In the winter of 1842–3, I restored, in the case of a young man from Salem, N. J., a nose of this description, accompanied with a shocking deformity of the features, which has been faithfully represented in Plate LXXIII. figs. 7, 8. This patient had for many years suffered from an extensive ulcerative affection of both nasal cavities,

* Traité sur l'Art de Restaurer les Différences de la Face selon la Méthode par Déplacement, ou Méthode Française, p. 252.

which had destroyed the entire septum, with the exception merely of the columna nasi, and caused the discharge of all the turbinated bones, and the two ossa nasi up to their connection with the os frontis. As the cicatrization of the ulcerated mucous membrane took place, it gradually drew inwards and inverted the whole of the cutaneous arch to which the nose had been reduced, and united the parts thus tucked in firmly to the angular processes of the os frontis, and to the inner faces of the nasal processes of the upper maxillary bones. No portion of the nose could be seen from the exterior except the twisted and deformed column, and this was drawn back beyond the level of the anterior margin of the nasal processes of the maxillary bones. The deformity was rendered more obvious by the forehead being unusually prominent, and the skin between the eyes, no longer supported by a bony bridge, being spread out broad as in epicanthus—from the cheek bones being large and prominent, from the unusual projection of the alveolar processes, and from the tumidity of the upper lip, which had been retracted upwards by the cicatrization of the nasal ulcer. In this state the patient was referred to me by Dr. Thompson, of Salem. Having, as was believed, completely arrested the disease by appropriate medical treatment, I determined to make an effort to detach the nose, by subcutaneous incisions, from its morbid connections, and raise it again as far as possible towards its natural position. From the absence of any precedent, it was uncertain how far the proceeding would be successful.

The operation was done in the following manner, before the class of the Philadelphia Hospital, Dr. Wm. Harris and several other medical gentlemen of this city being present. A narrow long-bladed tenotomy knife was introduced on either side by puncture through the skin over the edge of the nasal process of the upper maxillary bone. The knife was pushed up under the skin to the top of the nasal cavity, and then brought down, shaving the inside of the bony wall, so as to detach the adherent and inverted nose upon either side. The point of the nose could now be drawn out. The nose, however, still remained adherent to the

top of the nasal chasm. The knife was a third time introduced under the skin in a direction corresponding nearly with the long diameter of the orbits of the eyes, and the adhesions separated from the nasal spine and internal angular processes of the os frontis. This incision was exquisitely painful. The nose was now attached merely by the integuments, and was so completely loosened that the patient forced it out at once by a strong expiration through the passage, redeveloping to my surprise an organ of good size and of the natural form. It was incapable, however, of retaining its position, as it moved with every respiratory effort. To increase the dimensions of the nose—which remained less than had been natural to the patient—and diminish its tendency to fall a second time, the knife was again introduced through the lateral punctures, and the soft parts separated from the whole length of the outer surface of the nasal processes of the maxillary bones for the space of about five-eighths of an inch on each side. This involved the division of the branches of the two infra-orbital nerves and arteries. The portions thus loosened on each side were pushed over towards the nasal cavity, so as to increase the prominence of the nose. In this position they were held by a quilled suture, made with two ligatures, passed across the cavity of the nose from one cheek to the other. There was considerable bleeding, but the quilled suture sufficed to check it, so that no vessels needed to be tied. The sutures were removed on the third day, and the nose was left firm and well-shaped. In the course of a couple of weeks the skin at the root of the nose, having no bones to support it, became flattened out so as to impair the form of the organ. This I proposed to relieve by cutting out an elliptical piece from its middle, and then turning down in the space thus made a small flap of skin from the forehead, with the cuticle shaved off so as to gain a raw surface for adhesion on both sides. This flap, I believe, when united vertically in the opening, would have served as a new septum, and, by its tendency to contraction, kept the loose integument in its proper bridge-like shape. The patient, however, was so well satisfied with the organ

PLATE LXXIV.—BLEPHAROPLASTY.

RESTORATION OF SHORTENED LIDS. (*Processes of Grafe and Fricke.*)

Fig. 1.—Upper lid.—The cicatrix has been dissected out from the upper lid, and the tarsal margin drawn down to its proper level. The flap (*a*) has then been dissected up from the region of the temple, and drawn over and affixed by suture so as to fill the breach, as shown in *fig. 2*.

Fig. 3.—Lower lid.—The cicatrix has been dissected out, leaving the space (*b*); the flap (*c*) is seen raised from the side of the cheek. In *fig. 4* the flap is applied to fill up the breach at *d*, and fastened by suture to the margin of the palpebral space. The wound on the side of the cheek is closed by suture.

RESTORATION OF THE LIDS ENTIRE. (*Process of Dieffenbach and Von Ammon.*)

Fig. 5.—The upper lid, with the conjunctiva, which was here found too much affected to be saved, has been embraced by two incisions and dissected away so as to leave a triangular space. In *fig. 7*, a flap has been marked out by two incisions—one horizontal, and the other obliquely ascending—dissected up, inclined over and affixed by suture to the inner of the two incisions shown in *fig. 5*, so as to constitute the new lid.

Figs. 6 and 8.—In these two drawings a similar process has been followed for the reconstruction of the lower lid, with the exception that the tarsal cartilage and the conjunctiva have been preserved in *fig. 6*, to aid in giving better form to the lower lid.

Fig 1.

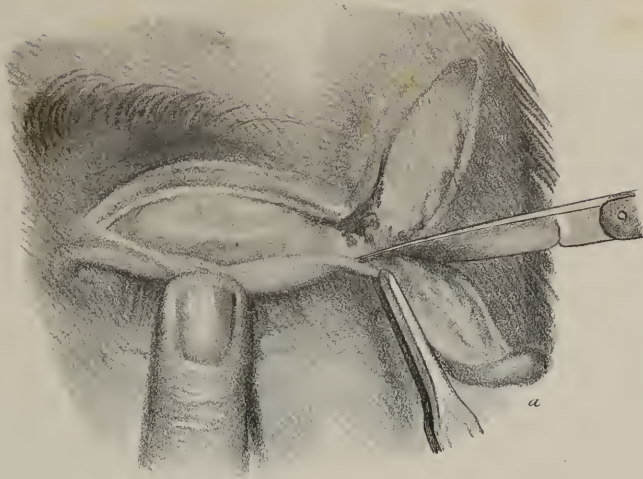


Fig 2

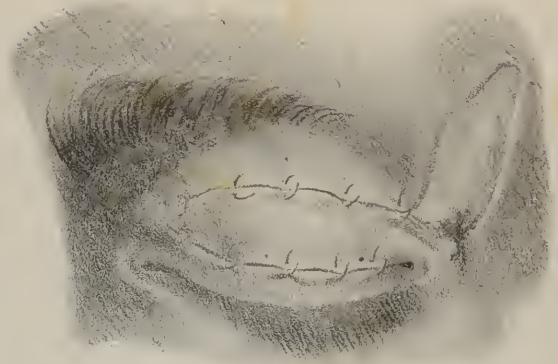


Fig 3

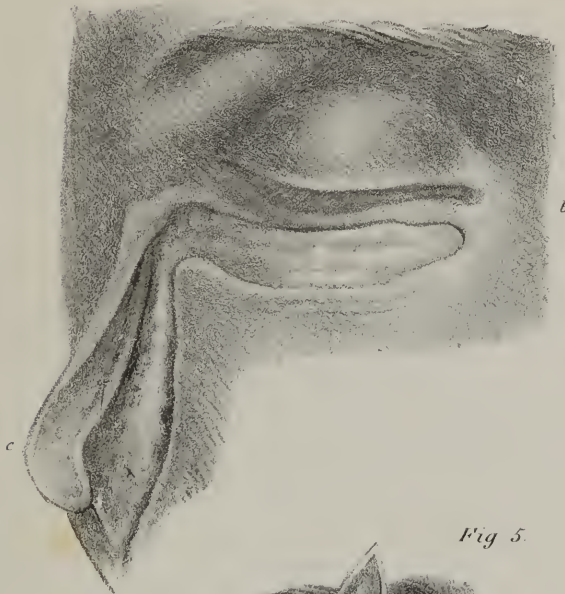


Fig 4

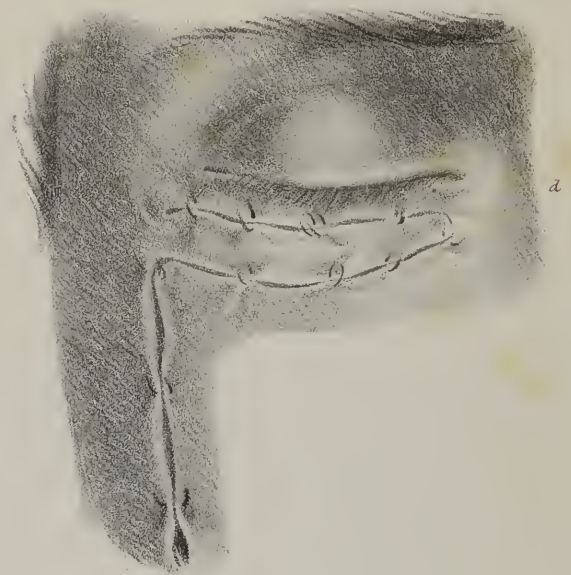


Fig 5

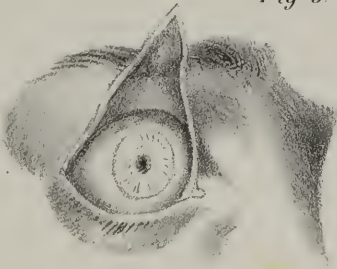


Fig 7



Fig 6

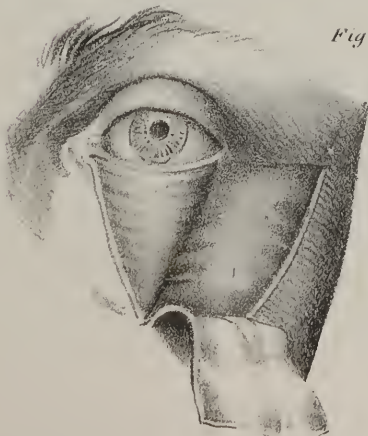
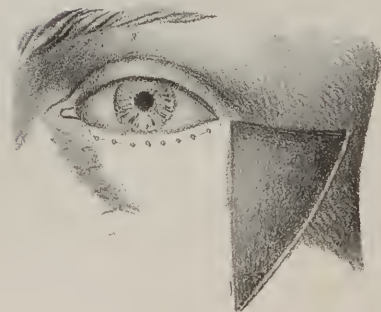


Fig 8



as it was, as to be unwilling to submit to anything more than the removal of the elliptical piece. This was done, and on leaving the hospital the nose presented exactly the appearance seen in Plate LXXIII. fig. 4.

In the case of a sub-officer of artillery, in which the dorsal ridge of the nose had been destroyed and the two alæ thrown out backward upon the cheeks eighteen months previously by the explosion of a musket, placed with its muzzle against the palatine arch in an attempt to commit suicide, Baron Larrey removed the deformity in a great degree by the following process, ten years previous to the operation of Dieffenbach, detailed at p. 357. He first detached the adherent tegumentary borders in all the circumference of the wound, and carried out the dissections over the maxillary bones towards the cheek, so as to give a sufficient extent of skin to enable him to form a new arched bridge over the nasal chasm. He then detached the adhesions, which the two divisions of the alæ and the upper lip had contracted with the opening left in the palatine vault by the passage of the ball. Having thus isolated all the soft parts *which formerly belonged to the nose*, he paired off the opposing edges with the scissors, and drew them up and united them on the middle line with six twisted sutures. The column which had been left, and formed a part of the left nostril, was attached to the tip of the nose by a stitch, and a wound which had been inflicted by the same injury on the upper lip closed by the common hare-lip operation.

Restoration of the column.—This may be required in those instances in which the column alone has been destroyed, or in cases where it has not been deemed proper to bring it down from the scalp in the operation for the construction of an entire nose by the Indian method. When the nose is large and the upper lip small, the column may be formed by taking out a longitudinal strip from the back of the nose, leaving the strip attached only at the apex. The strip is then to be twisted at its attachment, and fastened by suture to a groove cut for it in the upper lip—the space on the back of the nose being immediately closed with hare-lip sutures. If, on the contrary, the lip is large, a strip a quarter of an inch broad, comprising its whole thickness, may be raised from the middle of the lip, and left adherent only at its upper end. The frenum on the under face of the strip should be divided well up on the jaw, so as to allow the piece, when reverted and attached by suture to the tip of the nose, to take exactly the position of the natural column; for if great care be not taken in this respect, I have found that the root of the column will be drawn down during the cure toward the middle of the upper lip, so as to keep up some appearance of deformity. The fissure left in the lip is then to be closed with the twisted suture.

M. Serre proposes, in taking the flap from the lip to form the new column, to detach it from above downwards towards the labial margin, subsequently dividing the pedicle after the upper end of the strip had acquired the requisite adhesion to the tip of the nose. The chief advantage of this process, that of keeping the cuticular surface external, is not likely to be of sufficient importance to counterbalance the greater deformity liable to be produced in the difficulty of making, after this operation, a neat closure of the wound in the lip. M. Labat has, in one instance, taken the flap, after the Tagliacotian method, from the palmar face of the eminence at the root of the thumb. But this plan,

according to M. Serre, is calculated to maim the thumb and produce a poor substitute for the original structure.

BLEPHAROPLASTY.

The circumstances under which this operation will be required have been referred to when treating of Disease of the Eyelids. The processes by demi-rotation and traction, and inclination, are alone applicable to the reconstruction of the eyelids, the latter of which, according to the experience of the author, will in a majority of cases be found the most appropriate. From the delicate and complicated structure of the natural eyelid, and the tendency of the transplanted flap to become contracted and rounded off, the substitute, especially when an entire lid has to be formed and the conjunctiva cannot be preserved to form its mucous lining, must necessarily be more or less imperfect. It may diminish the deformity, and be made to protect and cover the eye, but it cannot be made to assume the numerous offices of the upper eyelid. In regard to the lower lid, which is but little movable, the operation will be more completely successful in removing the defect.

Demi-rotation and traction of the flap. (*Processes of Grafe and Fricke.* Pl. LXXIV. figs. 1, 2, 3, 4.)—This is suited only to cases of narrowing or shortening of one of the lids from burns or cicatrices, without destruction of the tarsal cartilage or the conjunctiva. If the conjunctiva be thickened or hypertrophied, it must previously be reduced to a healthy condition, either by topical applications or the use of the knife. The cicatrized or contracted portion of the cutaneous surfaces must next be surrounded by two elliptical incisions and removed by dissection, leaving the conjunctiva. The margin of the lid must then be brought down to its natural position, to allow an estimate to be made of the dimensions of the space to be supplied. A flap of the requisite form is then to be cut out from the side of the cheek or the temple, according as it is our object to replace the upper or the lower lid—one of the lines of incision in either case running, as directed by Lallemand, into the gaping wound left on the lid by the excision of the cicatrix. The flap is then raised by dissection, drawn over the gaping wound left in the lid, and fastened by suture at the margins, as shown in the drawing. The space from which the flap is raised is then to be immediately closed by suture.

Inclination. (Pl. LXXIV. figs. 5, 6, 7, 8.) *Lateral transplantation of the flap.* (*Process of Dieffenbach.*)—The cicatrix and degenerated skin are to be extirpated after having been included in two or three incisions, so as to leave a triangular wound with the base towards the surface of the other lid. The tarsal margin of the lid is, if possible, to be preserved by running the base line of the incision near and parallel with it. Sometimes two elliptical incisions will answer well for the removal of the cicatrix, the edges being afterwards dissected up so as to give room for the insertion of the new lid. If the eyelid be entirely destroyed, or degenerated by disease, whatever portion of the conjunctiva remains healthy should be dissected towards the ball, in order that it may afterwards be adapted as a lining to the new eyelid; the diseased parts are then to be embraced by two incisions, and excised so as to leave a triangular wound. The flap is to be raised, and slid in-

wards from the outer border of the wound. It should be of a size somewhat greater than the space to be filled. It is to be marked out by two incisions, one extended horizontally towards the temple from the outer end of the base of the triangle; the other, running from the temporal extremity of this horizontal incision, is to be made downwards if it be the lower—upwards if it be the upper eyelid that is to be restored. This second incision should not run quite parallel with the outer edge of the triangular wound, but incline a little towards it, so as to leave a pedicle to the flap of sufficient breadth to maintain its nourishment. The subcutaneous fat and cellular tissue are to be dissected up with the skin. When the bleeding ceases, the coagula are to be carefully removed from the inner surface of the flap and from the triangular wound, and the flap inclined over so as to fill the latter. The flap is to be secured in its new position by sutures. A stitch is to be first taken, so as to fasten it near the inner canthus. If any portion of the tarsus remain, the free edge of the flap is to be attached to it by three or four sutures of the same description; if the tarsus has been removed, it should be fastened to the cut margin of the conjunctiva. The inner edge of the flap is next to be united to the adjoining portion of skin by two twisted sutures. The wound in the temple is left to close by granulation, and dressed with charpie, over which are passed several strips of adhesive plaster to keep the transposed flap closely applied in its new position. Cold water dressings are afterwards to be kept assiduously applied. In my own practice, I have preferred to efface to a considerable extent the wound on the temple, by passing a long hare-lip suture across its outer angle, so as to close it in part by first intention and obviate the distorting agency of a broad cicatrizing surface on the new lid. This must be done, however, without putting any strain upon the inner row of sutures, or it had better be abandoned. The sutures are to be removed at the end of the second day—the flap adheres usually by the eighth, and at the end of the eighteenth or twentieth the cure may be expected. This mode of operating has been successfully followed by Lisfranc, Von Ammon, Eckstrom, Blasius, Fricke, Mütter, and the author of this work. The varying character of the deformity which different cases present, renders necessary frequent modifications in the mode of its performance, in regard to which the operator must rely on his own ingenuity and skill.

M. Serre, of Montpellier, prefers to supply the breach, especially as regards the lower eyelid, by dissecting a longitudinal strip of integument from the region of the face immediately below, and stretching it up by traction to the requisite extent and fastening it in its new position by suture. I have tried this process in one instance, but was disappointed in its results—the subsequent contraction of the flap drawing down and destroying the reconstructed lid.

M. Gerdy asserts that in many if not in most cases it will be better, after the extirpation of a part of the structure of the lids, to trust to the natural efforts of the system in repairing the deficiency, rather than to fill up the breach by the transposition of a piece of skin from the forehead, temple or face—the effort of the patient in corrugating the eyebrow to close the lids producing, as he believes, in the end a permanent rise or fall of the structures, according as the upper or lower lid has been affected, so as to greatly repair the defect. The opinion of M. G. has been founded on the results of a single case, and as it is in opposition

to general experience, cannot by any means be considered conclusive.*

CHEILOPLASTY.

The substance of the lips is not unfrequently so far destroyed by gangrene, ulceration, or the operation necessary for the removal of cancer,† that the resulting deformity can be in no way relieved save by a plastic process. All the various principles of the plastic art have on different occasions been resorted to for this purpose. It will not, however, be necessary here to do more than refer to those which have been found most appropriate.

Upper lip.—The operation of the author for restoring an entire upper lip by the Indian method, has been already described at page 352, and will be well understood by reference to fig. 3, Plate LXXII. In cases of shortening of the upper lip, resulting from the excessive use of mercury, Von Ammon employed the following process, which he has distinguished by the name of angular cheiloplasty, (Pl. LXXIII. figs. 1, 2). After loosening the lip from the jaw, he divided it at one angle by a vertical incision. The sides of the incision retracted immediately, so as to leave a vacant space of the form of an isosceles triangle, the base of which was on a line with the lower border of the lip. The incision was prolonged further upwards for about an inch, to give more space for the neat adjustment of a flap. A triangular flap with a narrow pedicle was then raised from the cheek and applied so as to fill the opening, as shown in the drawing. The flap was fastened by sutures, and the wound in the cheek immediately closed in order to effect union by first intention. In many instances it will be found necessary, in order to avoid any obliquity of the free edge of the lip, to repeat the operation on the opposite side.

Lower lip.—The flaps for the reconstruction of the *lower lip* by the Indian method, have been taken either from the lateral, anterior or posterior portions of the neck—their form and direction having of course to be varied in accordance with the character of the deficiency to be supplied. The process employed by Lallemand (Pl. LXXIII. figs. 5, 6,) consisted in removing the diseased portion by three incisions, which left an irregular quadrilateral opening as shown in fig. 5. The lip, of which in this case one-third had been removed, was then extended and united by suture to the other, so as to form a new commissure. A flap of integument was next raised from over the surface of the sterno-cleido-mastoid muscles, slid upwards with or without twisting the pedicle, and fastened by suture in the breach as shown in fig. 6. The wound in the neck was immediately closed, in order to facilitate the union of its edges by first intention. If the entire lip, or even the greater part of it, has been lost, this process will, however, be found very inadequate for its restoration; for the flap will become adherent to the jaw bone, and forms at best but a thin,

* Journal de Med. and Chirurg., Oct., 1844.

† Under the head of "Cancer of the lips," p. 246, it has already been observed that when the structure of the lips is not too extensively involved in this affection, it answers best either to remove the diseased part by a V incision, closing the gap with the hare-lip suture, or, when the free margin alone is affected, to detach it by a crescentic cut, and let the lip grow up again by granulation, as it commonly will, even when a considerable part of its free structure has been taken away.

flaccid, and membranous substitute that is neither sightly nor serviceable. In the reconstruction of the lower lip the Indian process has, indeed, but little to recommend it—some one of the processes detailed below, especially those of Serre, being much more worthy of reliance.

French method.—After the usual V incision has been made to pare off the edges of the cicatrized fissure, or for the removal of cancer if that be the cause of operation, the two sides of the lip may, if the loss of substance has not been too extensive to forbid it, be dissected from the maxillary bone till, by gentle stretching, their edges can be brought in contact and secured with the twisted suture. This is always to be preferred when it will suffice without straining the lip too much inwards upon the teeth. But where the loss of substance is great, various modifications of this process have been employed. In that of Chopart, two vertical and parallel incisions were dropped down from the ends of the V to the two ends of the base of the os hyoides. The intervening lamina was dissected from the jaw, down as far as the os hyoides, drawn up to the proper height, squared at its free surface, and fastened by the twisted suture to the sides of the remaining portions of the lips. Roux of St. Maximum modified this process by loosening the remains of the lip from the jaw bone, and continuing the dissection down to near the os hyoides, then stretching the integument loosened subcutaneously, like an apron, up to the proper level, flexing the head upon the neck at the same time. In one instance he found it necessary to remove a portion of the mental protuberance which was very prominent, to allow of a better adaptation of the flap. To facilitate the dissection in Roux's method, Lisfranc divided the lip by an incision extended through the median line in the direction of the os hyoides, closing the incision by suture after the new lip was raised to its proper level. Mr. Morgan, in addition to the vertical incision of Lisfranc, made another semicircular one crossing this below the chin. In the plans both of Chopart and Roux, the head must be held by bandages flexed upon the chest during the process of union; this is an inconvenient and painful position, and the difficulty which exists of maintaining the head immovable, must necessarily be very liable to cause a failure in the operation.

M. Serre of Montpellier, who is a strenuous advocate for the French method by displacement, for the removal of nearly all deformities about the face, seems to have been peculiarly happy in its application to cheiloplasty. He attaches the greatest importance to the preservation of the labial and buccal mucous membrane, for the purpose of lining with it the inner raw surface, and hemming it over the free margin of the new lip. The value of this measure had been taught beforehand by Delpêch, but M. Serre contests with M. Dieffenbach the merit of its methodical application as a ruling principle. According to M. Serre, we gain by this means not only a sensitive vermilion border for the lip, but a support likewise by which its form and dimensions are in a great degree preserved. In cancer of the lip even, he states that the mucous membrane is but seldom or ever specifically affected, and that it should be carefully preserved for the above purpose, in the excision of the morbid structure. The other points principally insisted on by this writer, are the free detachment of the parts, which he is desirous of stretching or shifting in position so as to fill the breach; the transverse incisions of the

mucous membrane on the inner surface of the flap so as to make it more easy of elongation; the care with which he marks out his flaps in mathematical form, angular or rectilinear as the case may require, so that they may fit with precision and without twisting in the breach which he has trimmed for their reception, and the completion of the operation, however extensive it may be, as far as possible at a single sitting. The author has frequently employed this French method by displacement in plastic operations, and while he accords to it, especially with the modification suggested by M. Serre, a high value in particular cases of deformities about the mouth and cheeks, believes it should not be relied on exclusively, nor ever resorted to, where it conflicts with what he deems an essential principle in plastic surgery, that of placing but a moderate degree of tension on the flaps which are employed in the reconstruction of lost parts. The following will serve as a simple illustration of the principle employed by M. Serre in excision of diseased parts. For an ulcer of bad character and irregular form, involving a part of the cheek, and the outer end of the lips at the right commissure of the mouth, he did not, in excising the part, limit himself to the outline of the morbid structure, but detached the part by the excision of two triangular pieces, the bases of which were at the corner of the mouth, the apices extending into the healthy tissues, a distance fully equal to the breadth of the tumour. The apex of one triangle was directed outward upon the cheek, the other downward upon the chin. After the removal of the diseased parts there were two lines to unite by suture, one horizontal and the other vertical, meeting so as to form a right angle at the corner of the mouth.

Process of the Author. (Pl. LXXVII. figs. 3, 4.)—In a case of cancer of the lip which required the removal of nearly all the free structure, the author practised the following operation. The diseased portion was detached by a semicircular section through the lip. A vertical incision was then run down over the symphysis of the chin nearly to the top of the os hyoides. This was converted into a crucial incision by a sweep of the knife along the upper edge of the base of the jaw. The two upper flaps were then dissected loose from the bone, and a triangular piece, with the base downwards, removed from the free end of each with a sharp pair of scissors. The two lower flaps of integument were in like manner loosened, and a triangular piece removed from the end of each, but with the base presenting in the opposite direction, as shown in fig. 3, so as to form a vacant space of a lozenge shape.* The two upper flaps were then closed at their lower border by a hare-lip suture. The effect of the traction necessary to bring these together carried the upper margin at once nearly to the proper level of the lip. A second pin was then introduced above the first. The two lower flaps were also raised and similarly closed with a pin which was made to rest on the mental protuberance, the effect of which was to give some additional elevation to the new lip, (though to a less extent than was expected,) and nearly efface the whole of the vacant space. The parts were covered with a light compress secured with a few turns of a roller, and the head retained for three days lightly flexed on the chest. The saliva escaped for some time through the opening at

* In a subsequent operation of this kind, for a less extensive species of deformity, I did not remove the triangular pieces from the lower flaps, and the case did very well without it.

the chin, rendering the cure tedious, but in the end the operation was in a good degree successful.

Process of M. Meyer of Bruges. (Pl. LXXVII. figs. 7, 8.)—This surgeon excised a cancerous ulcer which had destroyed the whole of the lower lip, the left third of the upper lip, as well as the commissure of the left side, by circumscribing the disease with four lines of incision, (previously traced out with ink,) and dissecting it away from the bone. The *first* line extended from the junction of the middle with the left third of the upper lip towards the left malar bone. The *second* was carried from the termination of this obliquely down to the external side of the lower jaw. The *third* was directed from the termination of the second obliquely downward and inward to the anterior part of the neck, which it struck in the median line; the *fourth* was made from the right commissure of the mouth obliquely downward and to the left side, so as to strike the third line near its middle. The large space shown at fig. 7, left by the excision of the diseased part, was closed, as seen at fig. 8, by approximating the two upper lines of incision with twisted sutures, and raising the inferior flap from the right side of the chin to the level of the upper lip, and then uniting the two sides of the third line of incision by three additional points of suture.

When it becomes necessary to reconstruct the entire lower lip, the process of Dieffenbach, by which the flaps are taken from the cheeks and include the whole thickness of these parts, will be found by far the most appropriate, as it allows of the formation of a thick and serviceable lip, consisting of skin, mucous membrane, and the intervening muscular tissue. The author performed this operation in the following manner, in the case of a young lady from Virginia, reported in full in the *American Journal of Medical Sciences*, for January, 1843, in whom the whole of the soft parts between the upper lip and the lower edge of the

chin, and all the lower alveolar processes, had in early life been destroyed by gangrene.

The patient was seated upright in a chair. The cicatrized edges which extended from the angles of the upper lip down to the chin, were pared off so as to present a large triangle, with the apex upon the chin. The corners of the mouth were next thrown widely open by an incision on each side, three-fourths of an inch long, in the direction of the auditory meatus. This was made by a sharp-pointed curved bistoury passed from the cavity of the mouth through the cheek, the whole thickness of which was divided on each side at one cut to the commissure. From the distal ends of these incisions a descending cut was made on either side, with a single sweep of the bistoury, obliquely downwards and inwards to the top of the lower jaw bone. Two flaps were thus detached from the whole thickness of the cheeks, lined with skin on one surface and mucous membrane on the other, and attached to the chin by a pedicle five-eighths of an inch broad. The flow of blood was arrested in a measure on each side as the division was made, by the thumb and finger of an assistant. In order to diminish the hemorrhage, the horizontal and descending incisions were made on one side before the other was touched, and the divided vessels immediately secured by torsion and ligation. The flaps were then rapidly loosened from the gum on the inside by a few strokes with the knife, and some few small arteries, which gave out blood, pinched and twisted. The loosened portions were then rocked over upon their pedicles towards each other, till their inner margins met on the middle line, where they were secured with hare-lip sutures. The traction of the flaps caused the portion of the cheek in connection with the outer margin of the pedicle to advance forwards, so as to supply in part the place occupied by the flaps previous to their change of position. An irregular triangular opening was still left at the cor-

PLATE LXXVII.—CHEILOPLASTY.

Upper lip.—The process of the author for reconstructing an entire upper lip is shown in Plate LXXII.

Figs. 1, 2.—These drawings exhibit the process of Von Ammon for filling up the breach left by the removal of a cancer, involving the commissure of the mouth and a portion of the cheek and upper lip. A flap has been raised from the side of the face in the direction of the ear, and applied in the breach. The part included in the dotted triangle seen in fig. 1, has been wholly removed, in order to allow the linear closure of the wound, as shown in fig. 2.

Lower lip.—Various processes have been devised to remove the different species of deformity met with in this region of the face.

Figs. 3, 4.—Process of the Author.—In fig. 3 is represented a case of cancer of the free margin, which was removed by excision on a level with the black line which is seen circumscribing the disease. A vertical incision was then made in the middle line in the direction of the os hyoides. This was crossed by a horizontal one over the base of the jaw. The four angular flaps were then dissected up from the jaw and the angles of the crucial incision removed, so as to leave a lozenge-shaped space. In fig. 4 the flaps have been united by the hare-lip suture—the effect of which, as shown in the drawing, was to raise the raw margin left by the excision of the cancer up to the proper horizontal level of the lip.

Figs. 5, 6.—Process of Lallemant, for closing the gap left by the excision of a cancer involving the commissure of the mouth and a portion of the lower lip and cheek. The diseased lower lip has been drawn up and attached by suture, so as to form the commissure of the mouth. A flap of integument has been raised from the side of the neck, demi-rotated and fastened by suture to fill up the space left by the portion removed.

Figs. 7, 8.—Process of M. Meyer of Bruges, for closing the open wound left by the incisions for the removal of a cancer that had destroyed the left half of the upper lip, a part of the same side of the face, and the inferior lip.

Fig. 1

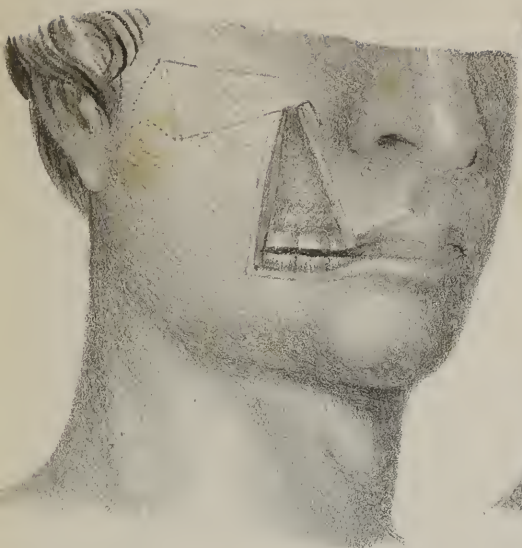


Fig. 2

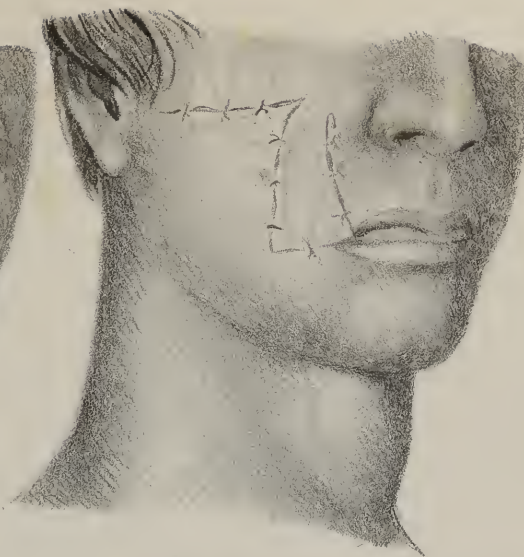


Fig. 3

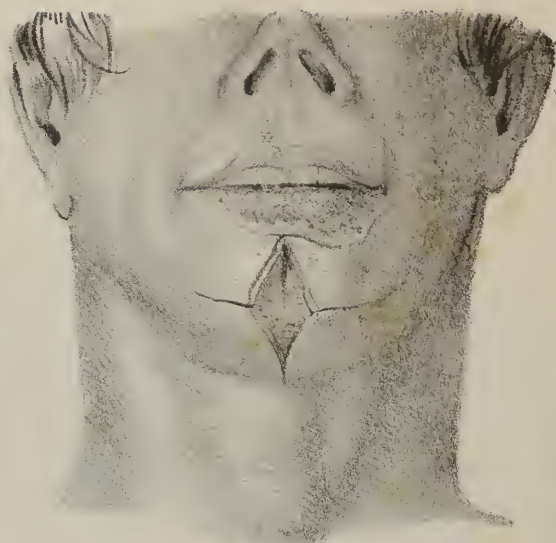


Fig. 5

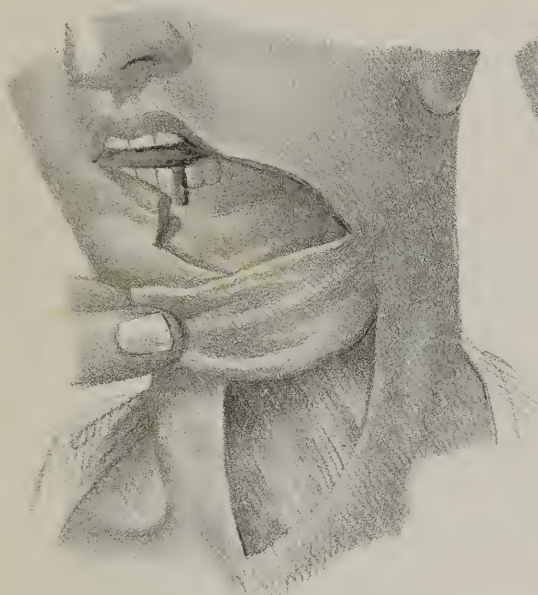


Fig. 6



Fig. 4.

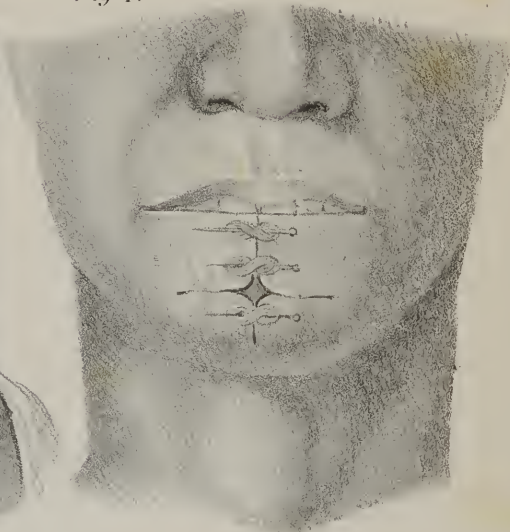


Fig. 7

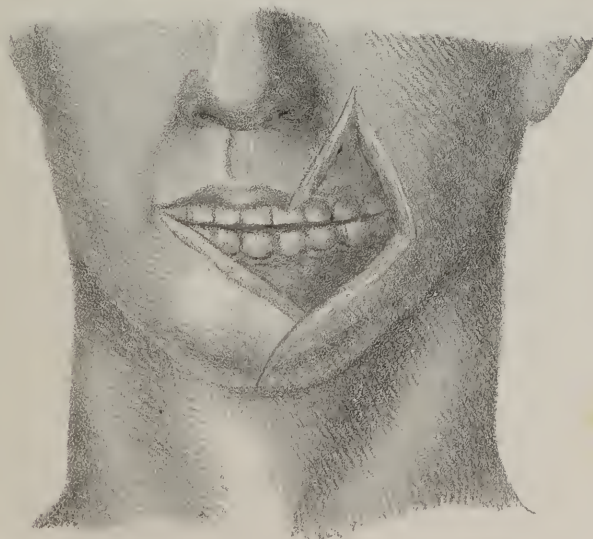
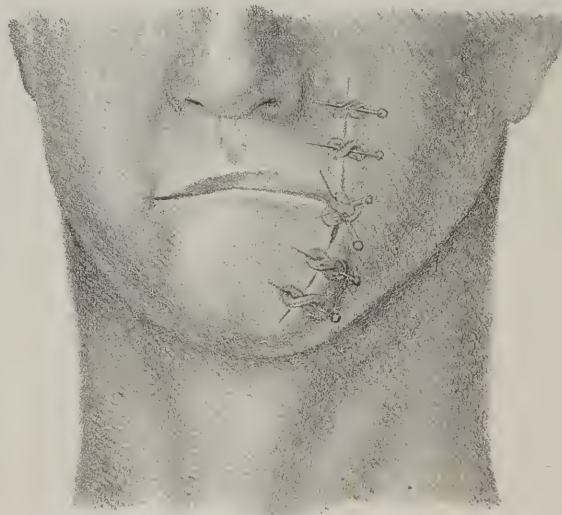


Fig. 8.



ners of the mouth. This was filled up by drawing the cheek from above downwards and forwards, and passing on each side two hare-lip pins, to connect the three sides of the triangle together. Though as much stress was put on the ligatures as was thought at all prudent, which should never be more than is sufficient merely to straighten out the flap, the opening could not be completely closed, a small, triangular, fistulous orifice remaining. The immediate effect, in regard to the improvement of the features, was magical. The flaps of the new lip, which as they were rocked inwards moved forwards in the direction of the line of their pedicular attachment, gave all the natural fullness and prominence to the lower lip. The descent of the protuberant cheeks restored, in a great degree, the natural roundness of the lower part of the face and, from a disagreeable, the patient presented at once a comely countenance. The result of the treatment of this case, which was necessarily somewhat protracted, was the restoration of the face to a form nearly perfectly natural. The new lip remained to a considerable degree movable, and fulfilled completely its natural offices of retaining the salivary fluid, and giving distinctness in articulation.

Dr. S. Chisholm, of Inverness,* restored the lower lip by the following neat process, which is almost exactly the same as the author's operation for the restoration of the upper lip, described at page, 352. The lower lip had been excised by a crescentic cut for the removal of a cancer, leaving the sockets of the front teeth exposed, and the saliva dribbling constantly over the chin. From the central part of the breach in the lip above the symphysis of the chin, an incision about three-quarters of an inch long was extended on each side obliquely downwards in the direction of the mental foramina, and from the ends of these, two other incisions slightly concave inwards were extended up to near the angles of the mouth. The flaps thus marked out were separated from the gums underneath, having their pedicles at the angles of the mouth. The flaps were then raised up and attached to each other in the median line by the hare-lip suture. The parts healed kindly, and the operation terminated successfully. Dr. Mütter (Phil. Med. Examiner for 1844) has done a nearly similar operation with a like successful result.

The following interesting cheiloplastic operation was recently performed by Dr. Mott,† of New York, upon a patient aged about 62. "The whole of the lower lip down to the chin was removed, together with the cancer which occupied it, by means of a free semilunar incision, which was prolonged on the right side to a little beyond the commissure, in consequence of the disease extending in that direction. The soft parts covering the extreme point of the chin, and on each side of it and below it upon the neck, were separated to some extent to within an inch from the os hyoides. The sound margin of soft parts was now brought up from the chin and neck to meet the upper lip. To prevent the puckering which this elevation of parts must necessarily have occasioned, a horizontal incision of an inch or more in extent was made through the cheek, close to each commissure. A stitch was introduced into each angle of the mouth, and a second one outside of that, through the cheek on each side. These nicely approximated the parts, and perfectly sustained the newly-formed

under lip. Adhesive plasters, and a double-headed roller were used to assist in firmly supporting and keeping in place the newly elevated parts and the lower jaw. The stitches were removed on the seventh day, and adhesion having taken place, the cure was soon after readily accomplished. During the first ten days the patient was supplied by liquid nourishment, passed into his mouth by a quill inserted into the mouth of a teapot. For some time after the stitches had been removed, the chin and soft parts continued to be supported by a double-headed roller. The cure was rapid and complete, without the slightest unpleasant symptom. The mouth looked exceedingly natural, and he conversed with ease. The carcinomatous ulceration had existed twenty years, having been unusually slow in its progress. The patient, as may be supposed, went home delighted. Being corpulent, and the parts soft and pliant, transverse incisions below were rendered unnecessary.

"*Making an entire new mouth.* Should a case present where there was necessity of making an entire new mouth, Dr. Mott suggests the measuring out a flap of the proper oval shape and size, transversely upon the supra-hyoid and sub-hyoid regions, with a long broad connecting pedicle. During the first days, and until adhesion of the edges of the flap to the excised edges of the corresponding opening to receive it should have perfectly taken place, breathing might be kept up by a small aperture of sufficient size, made in the centre of its longest diameter, and kept pervious by a curved piece of gum-elastic catheter. Dr. Mott has performed this operation on the dead subject, and it appeared to answer exceedingly well."

STOMATOPLASTY.

This operation, which consists in the reconstruction of the mouth, when its orifice is found narrowed or occluded by the cicatrization following a destructive ulceration of its soft and yielding tissues, has already been fully described at page 243 under the head of "Atresia Oris."

GENOPLASTY.—MELOPLASTY.

Losses of structure in the substance of the cheeks are susceptible of being remedied to a considerable extent by the various plastic processes already described, which it will be unnecessary again to notice in detail. Those which have been found particularly applicable here, are the approximation of the surrounding parts by traction after the edges of the opening have been pared off—and the transplantation of a cutaneous flap of sufficiently large size from the neck, the temple, or the forehead, in cases where the opening is too large to be obliterated by the former means.

In one case of extensive destruction of the cheek, and of a portion of the ala nasi, upper lip, and upper maxillary bone, Professor Roux resorted to the successive graftings of the flaps, denominated *migration*. The first flap was taken from the lower lip and united to the upper, and from this subsequently transferred to the cheek. A second flap was then taken from the lower lip, to supply the place of the one just removed from the upper lip to the cheek. The same principles of operation have been em-

* London and Edinburgh Monthly Journal of Medicine for 1842.

† Velpeau's Operative Surgery, by Drs. Townsend & Mott, vol. i. p. 649.

ployed to close the large aperture left after the extensive ulceration accompanying lachrymal fistula, the flap being taken from the side of the nose near the inner canthus of the eye, as practised by Dieffenbach—or from the forehead, after the manner of Delpêch.

We occasionally meet with instances in which, in addition to the loss of a great part of the cheek, there is an extensive destruction of the upper lip and the ala of the nose, which require complex and repeated operations, and are extremely difficult to manage. In a case of this sort, that of a young gentleman from Tennessee who placed himself under my charge during the last winter, there was, in addition to the deformities above noticed, which had been brought on by the excessive administration of mercury in his childhood, an entire destruction of the alveolar ridges of both jaws on the same side followed by false ankylosis so as to keep them closed. The disfiguration in this case was extreme, and the patient was compelled to feed himself with morsels taken in at the hole in the cheek. The first step was to restore the mobility of the lower jaw. This was accomplished by the excision of the fibrous bands between the jaws, the division of the masseter muscle, and the use of the screw dilator of Heister, as directed for this purpose at page 253. The next step was to supply the lost parts by a plastic process. The French method of displacement, so strongly recommended by M. Serre, was the one chosen, and an attempt made to fill up the greater part of the breach, after the plan of the same surgeon, as much as possible at a single sitting, so as to leave less to be accomplished at ulterior operations.

A flap was first raised from the cheek, to piece out the deformed ala, as directed at page 357, for the repairing of angular or crescent shaped losses of this part. This necessarily left a raw surface on the cheek. The under lip, which was very full, and had its outer corner bounding the gap on the cheek drawn off towards the temple of the same side, might, it appeared to me, be raised up as a flap, and attached to the raw surface by the side of the nose so as to close this space, assist in building the upper lip, and form a broad bridge across the large fissure which connected the mouth with the hole in the cheek, and thus re-establish the commissure. An incision, convex downwards and outwards, was therefore made from the outer side of the old commissure down to the symphysis of the chin; this flap with all the soft parts was dissected loose from the chin, so that by partially stretching the end of the flap, and partially by the displacement of the parts loosened beyond the cutaneous incision, the flap was readily brought round to the position assigned to it, and its point attached by suture to the raw surface by the side of the nose. There was now the opening in the cheek, the cicatrized edges of which had been pared away, and a gap left on the side of the chin by the labial flap just raised up, which required to be filled. To close these spaces, I began by running an incision downwards and outwards from the middle part of the cutaneous cut by which the labial flap was raised, so as to form two angular flaps, one above the other. The first of these flaps was dissected from the side of the lower jaw and slid up so that its upper border, which formed the lower margin of the opening in the cheek, could be attached by suture to the margin above, completely closing the hole, and resting by its anterior end in contact with the new labial commissure. The vacant space thus

left on the side of the jaw was filled up by the third angular flap, which was dissected up and the parts loosened subcutaneously in the direction of the os hyoides so as to cause them to yield readily to the displacement necessary to shut up the only opening which was now left.—The flaps were next carefully adjusted at various points by suture, and the face again assumed its natural form. The head, by the aid of bandages, was retained flexed on the chest, so as to keep the integuments relaxed below the chin. The union between the edges of the flaps was effected in most places by first intention. The end of the labial flap which was stretched up by the side of the nose, lost its vitality in consequence of the tension made upon it. This left a raw surface by the side of the nose to be closed by cicatrization, impairing to some extent the symmetry of the features of that side, and drawing partially down again the alar flap with which the nose had been patched; as much, however, had been gained by a single operation in this case, where there had been such extensive destruction of parts, as could with any reason have been expected. The opening in the side of the cheek was completely closed, the breach in the nose was to a considerable extent filled up, and the outlines of the mouth were restored so that the patient could take in his food by the natural opening for it. The only deformity of great importance remaining, was the elevation of the commissure on the diseased side, in consequence of the loss of structure by the sloughing of the point of the labial flap, and the absence of the upper lip, which I intended to supply with the integument from the arm by the Italian method. The union of the flaps between the jaws had necessarily restricted the extent to which these could be opened, so as to require again some separation from the bones on their inner face, and the use of the screw dilator. By the second operation, which was held in reserve for the restoration of the upper lip, all deformity might have been in a great measure removed, as this would have given an opportunity for the re-adjustment of the deformed commissure. Before sufficient time had elapsed after the first operation to render the second in my opinion justifiable, the patient became wearied, and went home with the expectation that he would return on a subsequent occasion and have the operation completed. The operation in this case was performed in the Philadelphia Hospital before the class in attendance on the lectures. The foregoing constitutes, perhaps, one of the most frightful cases of deformity to which the principles of plastic surgery have as yet been applied.

In the case of a young lady, in which sphacelation at the corner of the mouth had terminated by ankylosing the jaws and leaving a deforming cicatrix on the cheek, Dr. Mott* circumscribed the whole outer margin of the cicatrix with an incision, and dissected it away with all the newly formed parts included within it. The adhesions between the jaws were next divided and the dilator of Heister used to effect the opening of the mouth. "This point accomplished," says Dr. Mott, "the lips were brought together at the angle of the mouth by suture, and I proceeded to detach a portion of integument ('from over the side of the jaw and side of the neck') sufficiently large and of corresponding shape to replace the part removed. It was turned into the space it was intended to fill, leaving a tongue three-quarters of an inch in breadth connected with the adjacent part ('on the cheek'), and sufficient for all the purposes of circulation. The cut edges were adjusted

* Velpeau's Operative Surgery, by Drs. Townsend & Mott, vol. i. p. 707.

with extreme accuracy by means of interrupted sutures and adhesive straps; the lower wound was contracted as much as possible by adhesive plasters, and the whole covered with lint, compress and bandage." The result of this case was fortunate.

OTOPLASTY.

If the whole external ear be lost, its place can only be supplied by a movable one of artificial construction. Partial losses, however, may, as practised by Tagliacotius, be replaced by the elevation of a flap after the Indian method, from the scalp immediately adjoining the organ. The cicatrized margins of the stump of the ear are to be excised with the scissors. A portion of the scalp of appropriate size and shape, with its pedicle presenting to the concha, is then to be simply raised without twisting, and fastened by the interrupted suture to the raw margins of the ear. The wound on the scalp should be closed by suture and covered carefully with a compress and bandage to obviate the tendency of the pedicle of the flap to unite itself to the raw surface behind, and thus draw down and deform the ear. The pedicle of the flap should not, for fear of gangrene, be divided under fifteen or twenty days. The author has in one instance* restored the lobe of the ear, which, with the tragus and the skin covering the ramus and the base of the jaw, had been involved in one common cicatrix resulting from an extensive burn. The operation consisted first in raising behind the place of the lobe, a small flap forming the two-thirds of a circle, then circumscribing the remains of the lobe by a semicircular incision at its lower and front portion, and dissecting it loose so as to allow the tragus to take its natural position. The posterior flap was next doubled under the raw surface of the new lobe and fastened to its margins by suture, so as to give it a cutaneous surface on the side of the neck, and prevent its becoming again adherent. The wounds left on the neck were then closed by the hare-lip suture. A very considerable degree of improvement followed this operation. In general the success following otoplastic operations has been less satisfactory than in most other of the plastic processes.

STAPHYLOPLASTY.

This subject has been already referred to, under the head of Staphyloraphy, page 263.

URANOPLASTY.—PALATOPLASTY.†

A congenital opening through the bony palate, forming a communication between the mouth and nose, remaining open even after the closure of the fissure in the lip and velum by the processes described at page 245, is observed in the line of junction between the bones of the two sides, in some cases of complicated hare-lip. In many instances it occurs as a consequence of a wound, or arises from the caries or necrosis attendant upon a scrofulous or syphilitic affection. Metallic obturators, plugs made of prepared

* Vide Amer. Journ. of Med. Sci. for Jan., 1843.

† The term *uranisoplasty* is frequently applied to this operation; *staphyloplasty* has been used by some in the same sense, though its application should be restricted, as its name imports, to the operation for increasing the dimensions of the soft palate already referred to under the head of staphyloraphy.

sponge, or a roll of linen, have from the earliest periods been employed to fill up the passage, in order to prevent the food from passing into the nostril and enable the patient to speak intelligibly. Obvious inconveniences result from all such expedients, which, with the exception perhaps of a well-adjusted metallic plate, but imperfectly fulfil their objects, and occasion an offensive odour like that of ozæna. Where the orifice is not so large but that it leaves room for the formation of flaps from the palatine mucous membrane, a well-devised plastic operation, for the purpose of making a permanent closure, is greatly preferable to either. The process, however, is rendered difficult of execution, by the arched form of the palate, and the fibrous structure of the mucous membrane, which is not readily peeled from the bone in the form of large flaps. An additional obstacle to the union of the flaps, observed by the author in every case in which he has performed this operation, is found in the spasmodic cough produced by the irritation of this sensitive membrane.

Closure of a congenital fissure. Process of Krimer.—In a case of fissure extending through the soft and hard palate, this surgeon, after uniting the two portions of the velum, made a longitudinal incision on either side of the cleft between the bones, a few lines distant from the opening. The two flaps thus marked out were dissected off from the bone towards the middle line, reversed so as to present their mucous surface towards the nostrils, and united to each other in the middle line by a few points of suture. Success is said to have attended the operation. Dieffenbach has repeated the same process, with the exception that he raised but a single flap, in consequence of the extreme thinness of the coverings of the bone on the other side. This flap was loosened from the bone, reversed and attached by leaden wire ligatures to the opposite margin of the cleft, which had been made raw with the knife. The operation was not completely successful, though it reduced the fissure, which was previously an inch long, to two small orifices.

When the fissure is complicated with double hare-lip, the middle or incisory tubercle may be loosened from its attachment to the bone, and split obliquely from above downwards to near its lower end, so as to increase its length. It is then to be straightened out, have the cuticle removed from its other side, and pressed back so as to fill up the gap between the bones, to the margins of which previously made raw, it is to be attached by suture. In one instance, Sanson succeeded in closing the opening between the bones by cutting out a strip from the upper lip, (which was not involved in the deformity,) and reversing it so as to fill the gap in the hard palate.

Closure of an opening, formed as the consequence of disease. Process of Velpeau.—This surgeon succeeded in closing an opening in the hard palate, three-quarters of an inch long, and half an inch broad, left by a pistol shot, by dissecting up two ribbon-shaped flaps of a somewhat triangular shape, with their bases to the opening. One of these flaps was raised in front, and the other behind the perforation. These were applied over the opening, and united by suture at the ends.

Process of the Author. (Pl. LV. fig. 5.)—In one instance in which there was an opening in the centre of the bony palate, three quarters of an inch in diameter, I performed (four years ago) the following operation, reported by Dr. Wm. McPheeters, of North

Carolina, one of the resident surgeons of the Philadelphia Hospital.* The patient was seated upright in a chair, facing the light. Seating myself opposite to him, I marked out with a double-edged scalpel strongly curved near the point, and then dissected up two flaps of mucous membrane, of a somewhat triangular shape, one from the anterior and right side of the orifice, the other from the posterior and left side. The base of each flap, which was about three-quarters of an inch in extent, touched the roots of the alveolar processes. The pedicles, or adherent portions of the flaps, were about three-eighths of an inch wide, and near the margins of the orifice. The cicatrized border of the opening was shaved away with the knife. The mucous membrane was scarified superficially with the knife at the broader end of the flaps, (which were designed to be approximated more or less back to back in the middle of the fissure,) so as to diminish, as much as possible, the secretion of mucus, and facilitate the process of union, by increasing the breadth of the raw surface. Considerable bleeding followed, but it was in a short time arrested by rinsing out the mouth with alum water. The next step of the operation was the suture of the flaps, and their adjustment to the margins of the orifice. The flaps, when reverted, and their mucous surfaces turned upwards to the nostrils, readily met in the middle line, but it was necessary to confine them against the arched roof of the palate, which was some lines above the plane formed by their junction after they were inverted. To accomplish this object, two long, well waxed silken ligatures were each armed with a needle at both ends. With a pair of Physick's forceps the needles were passed through the broad end of the flaps, so that the loose ends of each ligature were brought out of the mouth over the raw surfaces of the flaps. The intermediate loops were passed into the eye of a curved probe, and carried from the mouth through the

* Philadelphia Medical Examiner, January 27, 1844.

fibulous orifice, and out at the anterior nares. Beneath these loops was next passed the end of a hollow bougie, which was carried into the nostril, so as to lay across the opening communicating with the mouth. The ends of the threads were now drawn on the side of the mouth, and the loops astride of the piece of bougie pushed back till they were over the orifice. The ligatures were then tied in the mouth, forcing up the flaps to the roof of the palate, and bringing them nearly to the level of the bougie. The flaps, in order to admit of the subsequent shrinking and contraction which always follow in plastic operations, and especially when union does not take place by first intention, a result which was hardly to be expected here, were made larger than absolutely necessary to close the opening. They formed, therefore, a keel-shaped projection downwards. To make the adjustment of the flaps to the arch of the palate still more perfect, a stiff, well-sharpened, semicircular pin, made of palladium wire, was passed from before backwards through both flaps, with the curve concentric to, and in contact with the arch of the palate. Over this a common twisted suture was made, as seen in Plate LV. fig. 5, and the adjustment of the flaps to the raw edge at the margin of the orifice was now rendered perfect. The extremities of the pin were cut off short with the pliers so as not to irritate the tongue, and the loose ends of the ligature removed. The bougie cut off just in front of the nostril was secured, so as to prevent its sliding. The operation was necessarily somewhat protracted, but was attended with little suffering.

The patient was put in bed, and kept on his back, fed on gruel, and took occasional doses of Tr. Opii Acetata. For several days everything promised an immediately successful issue. The bougie became loose on the third day, and was removed; the ligatures remaining. On the fifth day the pin was withdrawn; the flaps seemed to have united everywhere except at the back

PLATE LXXVI.—PLASTIC OPERATIONS.

REMOVAL OF DEFORMITIES ARISING FROM BURNS. (*After Professor Müller.*)

- Fig. 1.*—Front view of the deformity resulting from a burn in early life, relieved by the operation in figs. 2 and 3. The chin is held down and to one side, to within an inch and a half of the sternum—the space between being filled up with cicatrix. The mouth is held permanently open, and the tongue protruding.
- Fig. 2.*—The gap exhibited in the drawing is occasioned by the straightening of the head after a transverse incision of the cicatrix has been made three-quarters of an inch above the sternum, extending across from the margin of the sound skin on either side of the neck. The superficial fascia of the neck, the entire attachment of the sterno-cleido-mastoid of the right side, and the sternal attachment of the same muscle on the left, also required to be cut before the head could be brought into its proper shape. *The wound was six inches long by five and a half broad.* A flap was then raised from the left shoulder, the anterior boundary of which is represented extending down from the left end of the incision.
- Fig. 3.*—The flap, which was six inches and a half long and five broad, has been dissected up from the shoulder, left attached by a pedicle on the side of the neck, and applied over the gap left by the division of the cicatrix, to the margins of which it is fastened by several points of suture. The wound on the shoulder was closed, with the exception of its upper third, by suture and adhesive straps.
- Fig. 4* is a view of the patient after the completion of the cure.
- Figs. 5, 6, and Figs. 7, 8,* are representations of two patients before and after operations for their relief, similar in most respects to that described above.
- Figs. 9, 10.*—Removal of an extensive cicatrix involving a part of the arm and forearm, rendering the member nearly useless, cured by a process similar to the urethro-plastic operation of Dieffenbach.

Fig 1.

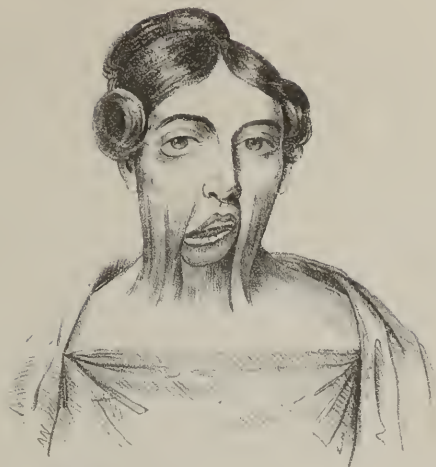


Fig 3.

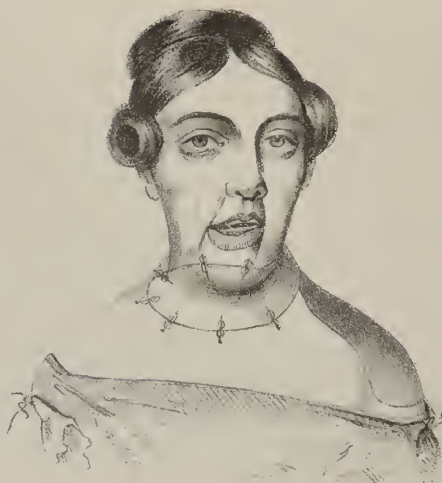


Fig 5.

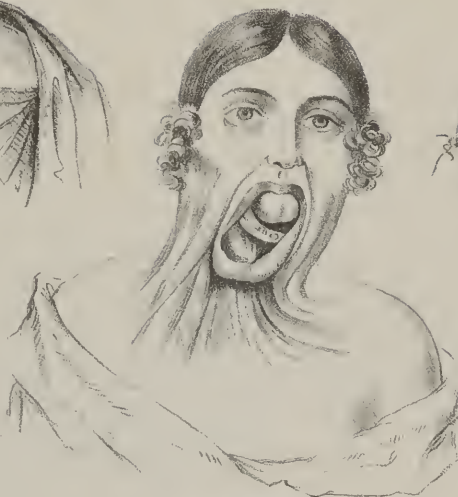


Fig 2.



Fig 4.



Fig 7.

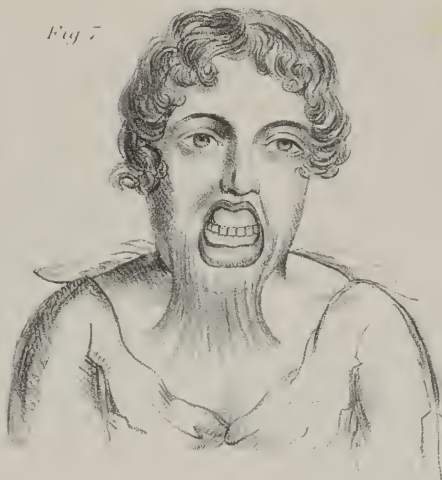


Fig 6.



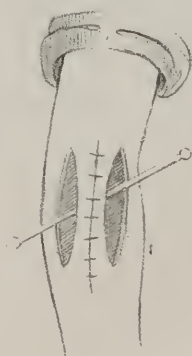
Fig 8.



Fig 9.



Fig 10.



part, where a small oblique opening was left. On the sixth day a violent spasmodic cough set in, not traceable to any other exposure than rising at night, when not well watched, in a room but illy warmed. The cough was accompanied with symptoms of bronchitis, for which he was cupped, blistered, &c. In one of these paroxysms the union partially gave way, and the ligatures, which were cutting out, were removed. On the subsidence of the bronchial affection the orifice was found diminished one-half in size. On stimulating the edges with a solution of lunar caustic, the opening was still further diminished by granulation, till it was about two-thirds the size of a common writing quill. Beyond this point it would not improve.

A repetition of the former operation on a small scale, and the pressure of a well-adjusted obturator, acting only around the margin, would in all probability have sufficed to close the orifice completely. But the patient, satisfied with his improved condition, and desirous of securing some occupation, left the hospital; still, however, wearing in the orifice a small pledget of lint during his meals.

On a re-examination of the patient a year subsequently, but little change had seemed to have taken place after his dismissal from the hospital. The surfaces from which the flaps had been detached, and which were allowed to fill up by granulation, were smooth, and, but for the white aspect of the cicatrized covering, presented a perfectly natural appearance.

BRONCHOPLASTY.

The closure of fistulous passages opening from the surface of the neck into the cavity of the larynx or trachea, has been attempted by the ordinary plastic processes, but with very indifferent success. The following process of M. Velpeau will be found deserving of the most reliance. The margins of the fistula are in this, as in the other methods, to be first pared away with the knife. A flap of integument an inch wide and an inch and three quarters long should then be raised over the larynx, being left attached merely by a narrow pedicle. The flap is next to be rolled on its outer surface so as to form a cylinder or plug. In this state it is to be inserted into the fistula and firmly held in place by two hare-lip sutures, (the pins traversing the plug as well as the margins of the orifice,) until union takes place. The pedicle is then to be divided.

POSTHIOPLASTY.*

The restoration of the prepuce is but seldom required. It was, however, resorted to by the Jews in former times, in order to avoid the persecution to which they were subjected. It may be accomplished in the manner described by Galen, by drawing the integuments of the penis in front of the glans, and dividing the skin merely by an annular incision posterior to the corona. The skin thus loosened is to be retained in front of the glans, by being secured to a catheter introduced through the urethral passage till the raw surface left behind the glans has become cicatrized.

CHALINOPLASTY.†

Though it will rarely be necessary to restore the frenum of the

* From *πρόθνη*, prepuce.

† From *χάλινος*, frenum.

prepuce when lost as the consequence of disease, it is well to know that such a result may be accomplished by a plastic operation, as individuals are sometimes met with, oppressed with so much morbid feeling on the subject of what they deem a deformity, as to render its performance justifiable. In two instances the author has succeeded very happily by the following process. Reversing the glans and grasping it laterally between the thumb and finger, a couching needle is passed in the middle line under the mucous membrane, so as to elevate this at the natural place for the attachment of the prepuce. An assistant then steadies the organ, while the surgeon with a delicate scalpel makes an incision on either side of the needle, in order to mark out a small triangular space with the apex towards the orifice of the urethra. The membrane is next to be dissected off from this space. A longitudinal fold of the prepuce is then raised on the lower surface of the organ; through the base of this a sharp-pointed bistoury is passed, cutting out at its place of anterior attachment, so as to detach a small, thin, triangular flap, with its apex in front. This flap is then to be drawn forwards, and secured by three delicate sutures on either side to the margins of the raw surface on the glans. The parts should be kept wetted with a cold lotion. Union readily takes place by first intention.

OSCHEOPLASTY.

In cases where the scrotum has been destroyed by sloughing so as to expose the testicle, nature alone is capable of producing an adventitious covering. But in those instances in which it is necessary to remove the scrotum in consequence of its enormous enlargement from elephantiasis, and the testicles (which in these cases are often found healthy) are preserved, flaps may be taken from the region of the thigh and groin, to form the new scrotal pouch and cover any portion of the penis that has been left exposed.

URETHROPLASTY.

When the attempts to cure fistulous passages which open through the spongy portion of the urethral canal, by cauterization or by simple approximation of the edges of the orifice made raw, fail of success, the following plastic processes may be resorted to.

Process of Dieffenbach.—If the orifice be small, this surgeon pares off its edges and makes a running suture round the margin, which when tightened purses up the integument and closes the opening so completely as to allow union in some cases to take place by first intention. When the orifice is large, he removes the edges so as to leave a crescent-shaped space with the long diameter corresponding with that of the penis. A longitudinal incision is then made on either side; the intervening skin is next raised in two bridge-like flaps, and united in the middle line by the interrupted suture. A catheter which should have been introduced previous to the operation, is to be retained in the urethra during the process of cure. The plan of this operation will be seen in Plate LXXXVI. figs. 9. and 10.

M. Alliot* has in one instance been successful in closing the opening by a modification of the Indian plastic method. He

* Malgaigne, Méd. Opératoire.

dissected up a quadrilateral flap on one side of the fistula, and removed an equal extent of skin from the opposite side. The flap was then stretched across and attached by suture in the bed formed for it by the removal of the piece of skin—the principal suture being by this means applied at a distance from the urethral passage.

If the fistula exist in the form of a fissure extending back from the glans penis, it may be closed by the process of M. Segalas, which consists in splitting the prepuce on the back of the glans, making the edges of the fissure raw, and retracting the prepuce backwards towards the scrotum, and confining it in position by suture. That there should be much prospect of success by this method, there must be another fistulous orifice for the escape of the urine at the perineum, as existed in the case of M. Segalas—or one must be formed by an incision, as done by M. Ricord, for the purpose of turning off the stream of urine and allowing none of this irritating fluid to come in contact with the flaps, till after these have become adherent over a silver catheter in their new position.

A variety of different processes have been employed for the cure of urethral fistula, but as they consist merely in the application of the common principles of operation already detailed, it will not be necessary to farther particularize them here.

FOR THE CURE OF DEFORMITIES RESULTING FROM BURNS.*

The various kinds of deformities resulting from the cicatrices left by burns, may be classed under the following heads:—Changes in the natural relation and direction of parts—more or less complete occlusion of the natural orifices—and anormal adhesions between parts that are habitually separate.

The deformities thus produced, it is scarcely possible to correct by extension with the aid of bandages and machinery, and it becomes necessary, to treat them with any prospect of success, to resort to some form of operation with the knife. Plastic surgery, in many of the cases which have hitherto proved intractable, offers a resource of great value to the surgeon. The subject of these deformities has been ably considered with especial reference to this mode of treatment, by Professor Mütter.

“1. *The nature of the tissue to be divided or removed.*—Although the ‘*tissue of the cicatrix*,’ as it is termed by Dupuytren, however produced, always presents certain characteristic peculiarities by which it may be distinguished from any healthy or natural structure, it yet exhibits *modifications* induced either by the *cause* or the *tissue* involved. The cicatrix of a *burn*, for example, can always be readily distinguished from that caused by sharp instruments; and again, both these from those resulting from cancers, ulcers, herpetic diseases, syphilis, or scrofula. The cicatrix of an ulcer in mucous membrane differs, too, from one taking place in the skin.

“Nearly all formations of this tissue, however, when dissected, present pretty much the same structure. We have, in the first place, a *delicate cuticle*, which may be detached by *vesication* or *maceration*. Beneath this inorganic tissue is a dense stratum com-

posed of strong fibres, which cross each other at different angles and are firmly bound together. This is the true ‘*tissue of the cicatrix*’ of Dupuytren, and the ‘*inodular tissue*’ of Delpèch, between which and the cuticle there is no deposit, as a general rule, of rete mucosum; hence the whiteness of cicatrices in the African. It contains no hair bulbs, nor sebaceous follicles, at least when the lesion is profound; and although furnished with both nerves and blood-vessels, is usually less perfectly organized than the parts whose loss it supplies.

“Lying under this tissue, we find a dense laminated substance, composed of the original cellular substance, which binds the cicatrix down, and offers, in many cases, the chief obstacle to the success of our operations. This is especially the case in severe burns; and whenever such adhesions exist, we must anticipate and be prepared for most extensive dissection if an operation be attempted.

“Another difficulty occasionally, though very rarely, presents itself in cases dependent upon burns—namely, the *vascularity* of the cicatrix. Whenever the tissue is red, sensitive, soft, and movable, we may fear hemorrhage; and this condition will therefore always render our prognosis, so far as loss of blood is concerned, more unfavourable than when the parts are pale, firm, inelastic, and adherent.

“2. *The thickness or profundity of the cicatrix.*—The depth to which the ulcer upon which the formation of the cicatrix is dependent extends, should always be considered in our investigation of the case; for the prognosis, as well as the treatment, turns chiefly upon this point.

“When the integument merely is involved, the cicatrix is, for the most part, elevated, thrown into bands, movable, and soft, the fascia beneath not being contracted. The motions of the subjacent parts are also normal; and hence, although the deformity may be considerable, yet the positive inconvenience is comparatively slight. In such a case the prognosis is favourable, and the operation required much less severe than under other circumstances. When, on the other hand, not only the integument, but the superficial fascia, cellular tissue, and muscles are attached, the inodular tissue is irregular, dense, thrown into hard ridges, immovable, or nearly so, and the parts which it unites are disturbed, displaced, or, as in the case of openings and cavities, obliterated, the prognosis is very unfavourable, and the operations indicated extensive and severe. This condition must not be confounded with that contraction of the fascia superficialis sometimes accompanying cutaneous burns, but often the result of other causes, many of which are inappreciable. For example, I have known the fascia of the palm of the hand gradually harden, contract, become thicker, and eventually inelastic, thus causing a permanent closure of the hand, the skin covering it being perfectly soft and pliable, while the cause of this change of structure was too subtle to admit of detection. Certain varieties of club foot are produced in the same way.

“This contraction is also frequently brought about by keeping a part too long in one position, and it may result from chronic inflammation of parts either above or below the fascia.

“3. *Location of cicatrix.*—The *location* of the cicatrices will also modify the prognosis and treatment. When vital or highly organized regions are involved, great caution must be exercised

* Cases of deformity from burns, successfully treated by plastic operation. By Thomas D. Mütter, M. D., Professor of Surgery in Jefferson Medical College. Philadelphia: Merrihew & Thompson, 1843.

in the delivery of an opinion favourable to any attempt at relief by an operation; and when such a procedure is deemed advisable, we should always warn our patient, as well as his friends, of the probable risk. In deep cicatrices of such parts, there is less danger of hemorrhage than one would imagine, and for the reason that, during the inflammation which accompanied or preceded the healing of the ulcer, the blood-vessels, especially the veins, in the vicinity, were obliterated and converted into fibrous cords; but we should always be prepared for some bleeding, as all the vessels are not included in this obliteration.

"4. *Extent of cicatrix.*—The *extent*, too, of the cicatrix is a point deserving attention. The wider and more extensive it is, the more difficult will it be to effect its removal. And we are hardly justified in the performance of an operation, unless there is an almost positive certainty of our obtaining a less deformed cicatrix than the one we wish to remove.

"Dupuytren gives some very excellent advice relative to extensive operating on cicatrices: when, for instance, adhesions between the arm and thorax, or thigh and pelvis are to be divided, he cautions not to complete the operation at once, but to proceed by fractions, and let the wound of one operation heal before we undertake another. In this way we avoid the dangerous consequences which may follow so large a wound as would be requisite to separate the parts at once. The same rule is applicable to extensive callous prominences.

"Another good rule is, to be certain, before any operation is attempted, that the limb retained in a faulty position is not incapable of being brought into a better one; if ankylosis, alterations of articular surfaces, or atrophy of the member is present, no operation should be attempted.

"5. *Age of cicatrix.*—The *duration* or *age* of this inodular tissue must also be taken into account. The advice of Dupuytren is, 'that no operation should be attempted until several *months* or even *years* have elapsed since the healing of the wound!' He believes that we run great risk of exciting inflammation and ulceration in the part, and, moreover, that inasmuch as the *disposition of the cicatrix to contract* is not lost for a long period after its complete formation, we do no good by an operation, which may indeed excite in this disposition a new energy. The *older* the cicatrix, then, according to him, the better, so far as an operation is concerned. This advice is at variance with that of some other surgeons, but it is, nevertheless, as a general rule, the safest to adopt. Especially is it the case where the inodular tissue is superficial, and curable by simple incisions, followed by extension and pressure sufficient to keep the edges of the wound separate from each other. There are instances, as, for example, where the cicatrix is so situated as materially to interfere with the comfort and convenience of the patient, where it would be proper to deviate from this rule, and operate as soon as possible; but these are rare exceptions, and do not militate against the correctness of the general proposition.

"6. *Peculiar deformity of cicatrix.*—The *power* with which these cicatrices sometimes contract is well known to every surgeon, but is sometimes overlooked in the desire for an operation. Mr. Earle has known it sufficient to bring the shoulders towards one another by a partial absorption of the clavicles. He mentions another case, in which not only the whole head was bowed down

towards the sternum, but the lower jaw curved downwards, so as only to admit of the last molar teeth coming in contact; the mouth being kept permanently open, and the direction of the incisor teeth so altered, that they projected nearly in a horizontal line. (This resembles very much the deformity in my own case, No. 1.) Cruveilhier mentions a case in which the carpus was luxated from the radius by a cicatrix on the back of the hand; and I have in my possession a similar specimen, and another has been deposited in the museum of Jefferson College by Professor Pancoast.

"An almost endless list of deformities of this kind might be cited, but the examples given are sufficient; and I need hardly add, that in all such no ordinary operation will prove of the slightest benefit.

"When, therefore, the original shape and function of a part have been destroyed, we should never operate unless there is a prospect of relieving at least the *deformity*. There are cases in which we must be content with this, while the loss of the function is an evil for which there is no remedy.

"Diversified as are the deformities from burns, Dupuytren is of the opinion that they may all be referred to five classes:—

"1. Those in which the cicatrix is too narrow.

"2. Those in which it is too prominent.

"3. Those in which it has formed extensive adhesions.

"4. Those in which a cavity has been obliterated.

"5. Those in which organs or an organ has been destroyed.

"This classification has not been adopted by all, although to a certain extent it is correct.

"*Operations.*—It must be obvious that as the cicatrices present a great variety of shapes, occupy different positions, and penetrate to different depths, the operations for their removal must be modified to suit the case.

"I. *Narrow cicatrix—Incision.*—Suppose, for instance, the deformity consists in the formation of a narrow band of inodular tissue, which either causes inconvenience from the motion of the parts being interfered with, or from its unsightliness—what operation is most likely to relieve it? Surgeons are divided on this point. While some recommend *incision of the band*, as performed by the ancients, others tell us that such attempts are almost, if not always useless, and what is worse, that they even increase the difficulty, each incision in cicatrizing shortening the band more and more. The latter view, though in the main correct, is rather too exclusive, for there are many examples of entire relief having been obtained by incision and pressure, reported by Dupuytren, Velpeau, Hourmann, Bérard and others. Much depends on the duration of the case, and the depth to which the cicatrix extends. If of long standing, and sufficiently deep to involve the fascia superficialis, the probability is, that the operation will fail, owing, as Mr. Earle has clearly shown, to the contraction of the muscles, which thus acquire a new sphere of action, and to the adhesions of the fascia. In recent and superficial cicatrices, however, the plan will answer, and in its execution there are *three indications* to be observed.

"1. The incisions are to be made at several points, and completely through the tissue; a scalpel or bistoury is the instrument to be employed.

"2. The parts are then to be separated from each other, and

placed at once, if supple and yielding, in their natural position; if rigid, a slow and gradual extension is to be kept up by splints and bandages until our end is accomplished.

"3. Extension is to be kept up some time after the completion of the cicatrix, and if new fræna or bands form they must be divided.

"II. *Prominent cicatrix—Excision.*—When the cicatrix is too prominent, forming, as it sometimes does, a most shocking deformity, and often causing neuralgic pains, there are several plans employed for its removal; and as there is rarely any unnatural contraction of the parts beneath, the elevation being almost entirely confined to the skin, all the operations in use are limited in their extent to this tissue. The one most to be relied on is that proposed by Dupuytren, in which there are three things to be observed.

"1. The projecting point is to be sliced off on a level with the skin.

"2. The edges of the wound are to be kept apart by appropriate machinery.

"3. The surface of the wound is to be frequently cauterized with argent. nit., so as to keep it rather below the level of the integuments.

"Instead of slicing off the cicatrix, others, as Higginbottom, Cleghorn, &c., prefer the application of a caustic, by which the prominence is *sloughed out*. The nit. of silver, the chloride of zinc, nitric acid, and arsenical paste have all been employed; but it is obvious that this process is more painful, more tedious, and more likely to leave a bad scar, than that recommended by Dupuytren, and should consequently be rejected.

"III. *Extensive adhesions.*—When the deformity consists in adhesions by which parts are approximated that should remain separated, or others separated that should remain in contact, numerous operations have been proposed.

"Dupuytren's practice was as follows:—

"1. After having divided the adhesions, he dissected them freely to beyond their origin.

"2. Then he drew the parts asunder.

"3. Methodical and constant pressure was maintained on the point whence the cicatrix must proceed, which is always at the angle of union of the parts.—(*Clin. Chir.*, tom. ii. p. 69.)

"This plan succeeds in some cases, but very often fails.

"In consequence of this operation so frequently failing in the accomplishment of a cure, Sir James Earle, and Delpech of Montpellier, revived the operation of Hildanus, which consists in—

"1. Cutting out the cicatrix.

"2. In bringing the edges of the wound together so as to cover the raw surface from which the cicatrix was removed.

"3. In extending the part by splints and bandages, and keeping them in this condition while cicatrization was going on, and for some weeks afterwards.

"By this plan the contraction takes place in a lateral direction, and not in the long axis of the part upon which it is performed, and the cicatrix is soft, linear, movable, and as extensible as natural integument. This is a favourite operation with Brodie, James of Exeter, Hodgson, and many others, and whenever practicable is probably as good as any that can be devised; but where the cicatrix is broad, irregular, situated on the neck, or different parts of the face, it is obviously a method altogether improper.

"I have succeeded, by slightly modifying this operation, in curing a very extensive cicatrix, involving the arm and forearm, by which the whole member was rendered useless. After cutting out the cicatrix, as advised by Hildanus, I found it impossible to draw the edges of the wound over the raw surface, and it at once occurred to me that the only method by which I could secure success would be that which I have frequently resorted to in the operation for cleft palate, when there was difficulty in approximating the edges of the cleft, and which consists in making *lateral incisions* at some distance from the edges of the tissue to be displaced.* Doing this, and then drawing the wound together, I covered the raw surface perfectly; and then dressing the two lateral wounds with warm water dressing, made them unite by granulation. The operation succeeded most beautifully, and may be resorted to in many similar cases.

"A plan, the principle of which was clearly recognized by Celsus, has been put into execution by my friends Drs. J. Rhea Barton, and G. W. Norris, and also by myself, in extensive cicatrices about the neck, without, however, deriving much benefit from its employment. The operation consists in—

"1. Making an incision through the integuments at some distance from the origin of the cicatrix; in other words, in perfectly sound skin.

"2. In dissecting up the skin and cicatrix as far as possible, without making any new incisions in the skin itself.

"3. In the separation of the divided parts, so that the cicatrix slides from its original position, leaving a raw surface to heal by granulation. The operation is severe, and though sometimes useful, is not much to be relied on in cases of extensive contraction.

"The operation, which, of all others, is most entitled to our confidence, especially in cicatrices of the neck, cheek, eyelids, nose, lip, is that in which '*autoplasty*' is brought into service. In all such operations, we are governed by the same principles and pretty much the same mechanical details. They consist in—

"1. Dividing the cicatrix so as to produce a raw surface in some part of its extent; or cutting it out entirely, as proposed by Hildanus.

"2. In applying to this raw surface a piece of healthy skin taken from the neighbouring parts.

"3. In attaching this skin by suture to the margins of the wound in which it is inserted.

"4. In approximating the edges of the wound, from which the skin has been removed.

"5. In separating, by appropriate agents, the parts too closely approximated, and keeping them in this condition some time after the flap has united.

"6. In applying oleaginous frictions, and motion to the new made parts to give them flexibility and softness.

"Many shocking deformities from burns have been relieved by the performance of operations conducted on these principles; for example, the eyelid, the cheek, the nose, and the lip have all been restored: but I believe I may claim the merit (if merit there be in adapting an old principle to a new operation), of having first

* This is the same as the urethro-plastic operation practised by Dieffenbach, described at page 367.

performed an operation of the kind for the relief of extensive cicatrices of the throat.

"Mr. Liston, whose surgical acumen and boldness no one will deny, distinctly states, in his last edition of the 'Elements of Surgery,' p. 263, 'that such defects are beyond the reach of surgery,' and gives a drawing illustrative of the appearance of a person so afflicted—which drawing is almost a fac-simile of my case No. 1. I have also carefully examined nearly all the modern works on the subject, and find no mention of such an operation having ever been performed. Velpeau, in his 'Médecine Opératoire,' article 'Cicatrices Vicieuses,' merely hints at the possibility of such an operation, but this is all.

"In very extensive cicatrices of the neck, it may be well to modify the operation so as to take a *flap from each side*, by which means we shall avoid the risk of a very large single flap.

"4. *Cicatrices complicated with obliteration of cavities.*—Where the cicatrix produces partial or complete obliteration of a natural opening, as the mouth, &c., incision of the angles, and the introduction of tents *larger* than the *natural* opening, will occasionally do good: but for the most part all such attempts fail, and it becomes necessary to perform the operation of Dieffenbach, described at page 243 of this work.

"5. *Cicatrices complicated with loss of organs.*—Where organs are entirely destroyed, nothing short of a 'plastic operation,' the aim of which will be the construction of an organ as much like the original as possible, offers the slightest prospect of benefit to the patient."

II. SUBCUTANEOUS OPERATIONS.

The subcutaneous section of muscles, tendons and fasciæ, has been employed in aid of that department of the science denominated *Orthopedic Surgery*, which has for its object the correction of deformities arising from the excessive action or permanent shortening of these parts. Some of the older surgeons—Tulpius, Heister, &c.—as it would appear from their writings, entertained the idea of dividing the tendo-Achillis for the purpose of facilitating the straightening of club-foot by mechanical measures. They seem, however, to have been in a great degree restrained from its performance by an erroneous opinion in regard to the liability of tetanus arising from the division of tendinous structures, and in part also from the imperfect knowledge of the nature of these deformities, which they attributed not so much to the preternatural retraction of the muscles on the side to which the part was drawn, as to the weakened or paralyzed condition of those on the opposite portion of the limb. It is not, therefore, a matter of surprise that, with the exception of a few isolated instances of division of the tendon, the treatment of these deformities should have been confined in a great degree to the instrument maker, or that mechanical means, singularly improved as they were by the genius of Scarpa and Delpech, should have been—a fact within the memory of all—in but a very small proportion of cases susceptible of effecting perfect relief. To Stromeyer of Hanover belongs the

merit of having established the proper etiology of these affections, as well as that of reviving and improving the process of dividing the tendons—for there are few instances of this operation sufficiently authentic to be relied on prior to his first operation performed in 1831, except that of Thilenius in 1782, who severed the skin and tendon in one transverse cut—and that of Delpech in 1816, which consisted in dividing the tendon between two parallel incisions of the skin made upon its sides. Stromeyer ingeniously modified the process of Delpech, by substituting two small punctures for the cutaneous incisions, in order to avoid the introduction of air into the cavity of the wound, which, in the operation of Delpech, occasioned the suppuration and exfoliation of the tendon. In 1836 the second puncture, or that for the exit of the point of the knife, was suppressed, leaving the proper *subcutaneous method of operation* as it is now performed, to consist of but a single minute puncture of the skin, however extensively the subcutaneous structures are divided.

The safety and innocency of this operation, when properly executed, *so far at least as local symptoms are concerned*, depend upon the perfect exclusion of air from the cavity of the wound. This places the divided parts nearly in the comparatively safe condition in which they are found when accidentally ruptured by muscular action, and the fibrin of the blood which fills up the gap left by the separation of the divided structures, becomes rapidly organized without the development of inflammatory action. The axiom laid down by M. Guérin,* "that all subcutaneous sections, in whatever situation made, or whatever be the nature of the structures divided, participate in the property of the subcutaneous section of tendons, that is to say, never inflame or suppurate, but immediately reunite," cannot, however, the author believes, be considered true save as the general rule.

The well-founded distrust in the efficacy of the instrumental means of cure devised by Scarpa and Delpech, the principles of which have been retained in use up to the present day, found for the Stromeyerian operation, when promulgated in 1833-4, earnest advocates among surgeons of the highest standing in all parts of the civilized world. The division of contracted parts became an almost daily operation in the hands of many practitioners, and was applied without discrimination to nearly all kinds of muscular deformity, and without due regard to the long-continued after use of mechanical distension, for which it properly served merely as a means of diminishing the pain and shortening the period of the treatment. Everything that resisted the straightening of a limb it was deemed necessary to cut, and in some instances the section of different tendons and muscles was carried by Guérin and others to a most fearful extent. The consequence of this has been, that before the method had become ten years old, before indeed time had been allowed for cool experience to indicate the cases proper for its employment, many of those who do not reason broadly, disappointed in their high-wrought expectations, have been disposed to abandon it and rely exclusively on the mechanical means of cure. The author, who has at no time been a strenuous advocate for tendon-cutting in articular deformities, believes, however, that the unprejudiced practitioner will in many cases find it advantageous to divide with the knife the contracted part that offers

* *Essais sur la Méthode sous Cutanée*, par le Docteur Jules Guérin, Paris, 1841.

most resistance, and then resort to mechanical distension to complete the straightening of the limb, maintaining it for a long time subsequently in its proper position, until the cicatrix, filling the gap in the divided tendon, loses all its tendency to contraction.

Surgical pathology.—The morbid condition observed, varies more or less according to the part effected. The muscles on the side of the deviation are found altered in their structure, and of a length less than would be natural for the limb. In cases of temporary or recent deviation arising from an obvious cause, as the disturbance of the nervous centres, or from the joint affected being on account of disease in some part of the limb held for a considerable period in a bent position, the muscle is not organically changed, but in a mere fixed state of contraction, susceptible, if subjected to mechanical distension, of being elongated and restored to its previous physiological condition. But if the deformity be congenital, or the muscle has remained for many years together in its contracted state, it will be found permanently shortened or retracted, diminished in volume, but imperfectly nourished with blood, forming at its belly a fibrous rather than a fleshy mass, and incapable of being stretched but to a small extent. An interesting fact connected with this condition of the muscles is, that if they admit of being stretched by mechanical means, or have their tendons divided so as to be relieved from the state of permanent tension, their nutrition is rendered more active, and they become gradually larger, longer, and more yielding. It is only in the cases of fibrous degeneration of the muscle that the use of the knife is ordinarily needed. The bony structures of the parts involved are usually found more or less diminished in length and diameter, and, if the deviation has been great and long-continued, with more or less alteration of their articular faces. The ligaments and aponeurotic membranes undergo a modification somewhat like that of the muscles; being on the concave side of the deformity shortened and thickened, and having a corresponding elongation on the opposite side of the member. In some inveterate cases the ligaments have been found ossified on the side of the deformity. The vessels are diminished in size, so as to account for the innutrition of the limb and the coldness which is at the same time usually observed. The nerves remain ordinarily of their usual size, and in some instances have appeared to me on dissection preternaturally large.

In many old cases of deformity the articular structures will be found to have suffered so much alteration, especially as regards their shape and the cartilaginous coating of the bones, as to be incapable, even if the form of the limb were restored, of fulfilling but very imperfectly their natural functions. The attempt to rectify deformities of this description, from their nature almost incurable, is perhaps one of the causes of the partial discredit into which orthopaedy has latterly fallen.

Mechanical Distension.

The employment of an apparatus for mechanical distension, which forms an indispensable part of the treatment for deformities, and is sufficient of itself for the cure of a large proportion of the cases met with—especially in young subjects—cannot from the nature of this work be alluded to but in very general terms. The reader is referred for further information to the various treatises and communications which have appeared upon the subject. It

may be well, however, to observe, that in cases where the subject is young and the deformity not great, instruments of the simplest character devised for the purpose of retaining the foot in its natural position, either with or without the division of the tendon of the shortened muscle, will frequently suffice for the cure. The principles by which the construction of the more perfect and efficient kinds of apparatus should be regulated, are thus ingeniously laid down by M. Guérin in his report to the French Academy. The observations are made especially in reference to the foot, but they are applicable also to deformities in general. “Let the apparatus be constructed of as many parts as there are joints in the deformed foot, which serve as centres to the distortion. Make the centres of motion in the apparatus correspond with the joints of the foot to be straightened, and make the chief force of the action of the machine, as well as its line of direction, correspond with the chord of the morbid curvature. Concentrate the action of the machine upon the smallest space possible, and let the surface by which the body of the machine is secured to the limb be as great and as even as the nature of the case will admit. These general principles apply to the construction and application of all orthopaedic machinery, for all deformities of the skeleton are alike as to their material causes, present similar obstacles to contend with, require to a great degree similar mechanical appliances, and demand like attention as respects their use. In every case we have an angle to open, a curve to straighten, ends of bones to move over one another, and consequently in all cases to establish points of central motion with levers to move around them. In all cases it is necessary to accomplish much with little effort, that is to say, to distribute the force in the best manner so as to gain the most effect with the least pain.”

There are, however, cases in which the use of even the best constructed machinery, unless assisted by the division of the resisting fibrous structures, would require to be employed with a force so great or so long-continued as to endanger the integrity of the bones, muscles, joints or investing structures, and excite a constitutional irritation liable to awake a dormant affection of the lungs or heart, of which some melancholy instances have come to the knowledge of the author.

General rules for the subcutaneous section.

The *first step* in the section of every tendon or muscle, is to place the parts in such a position as will render the structure to be divided most tense and obvious. The *second step* is to raise a fold of skin over the part to be cut, and then introduce the knife flat at its base, or make a puncture through the skin with a lancet-shaped instrument if it be thought necessary to use the blunt-pointed tenotome. Before the section of the tendon is made, the fold of skin must be relaxed so as to fall flat on the blade and prevent the introduction of air into the wound. *Third step. Section.*—This may be made either from without inwards or towards the surface, according as the tenotome is introduced above or below the part to be cut. The section is to be made either by simple pressure combined with traction, or by slight sawing with the knife—the left fore finger resting upon the skin above the instrument. In some instances, as in division of the tendo-Achillis, it answers well to carry the knife across the tendon in its most relaxed state, and then flex the foot so as to bring the tendon up

firmly against the edge. The complete severing of the tendon is evinced by a noise like that of a snapped cord, and as further evidence that this has taken place, the skin can be sunk in by the finger between the divided ends, and the limb moved further than before in the direction opposite to the curvature. The knife is then to be withdrawn, the finger following it, so as to force out the blood and any bubbles of air that have entered, and the puncture closed with a piece of adhesive plaster.

If several tendons or muscles are involved in the affection, the division of such only, as before observed, is to be made as is considered indispensable, and the rest subjected to distension by mechanical means. There is a difference of opinion among surgeons as to the time at which the after-distension should commence—some instituting it immediately after the operation—others deferring it till time has been allowed for soft union to take place between the divided parts. I have repeatedly tried both methods, and prefer to make at once a separation of at least an inch in extent between the divided tendons. M. Bouvier has found by experiment that a separation of two inches after the section of the tendo-Achillis, does not prevent the reunion of the ends by an intermediate substance, capable of acquiring rapidly such size, form, and resistance, as to fulfil perfectly the uses of the tendon with which it is connected. In a dissection of a bad case of club-foot in an adult, successfully operated on by my friend Prof. Wm. R. Grant, the new growth was found nearly two years after the operation much larger than the original structure. It is generally conceded that the union between the ends is established by the fifth day after the operation, is capable of resisting a powerful effort by the twentieth or thirtieth, and differs at the end of two months but very little from ordinary tendons. If, however, after section of this large tendon, the separation of the ends should take place immediately to a greater distance than two inches, there is reason to fear that they would not reunite, and that the action of the muscle would be lost. In proportion as the size of the tendon is less, or when the sheath around the muscle is thin and serous, the smaller is the distance which it is allowable to separate the ends. For these reasons, the division of the tendons for deformities of the fingers, wrist, or elbow, is attended with a greater risk of loss of function than analogous operations on the lower extremity.

The reunion of a contracted muscle, the division of which, as above directed, by a subcutaneous section is sometimes rendered necessary in the cure of deformities, is to be made much in the same manner as a divided tendon. Muscular incisions five inches in length have been inflicted in this way by M. Guérin, and the fact is noticed here more as matter of history than for imitation. The blood which is immediately poured out, and sometimes to so considerable an extent as to form a fluctuating tumour below the skin, is usually absorbed at the end of forty-eight hours; and in its place is found a soft organizable substance, which becomes daily more firm, and takes finally the nature of fibro-cellular structure, by which the divided portions of the muscles remain afterwards connected. It offers some interruption to the transmission of the nervous fluid, so as to render the action of the muscle weaker. Stromeyer, on these grounds, has recommended the incision of the muscles, when acting with too much force, relatively to that exercised by their antagonists.

MYOTOMY OF THE HEAD AND TRUNK.

SECTION OF THE MUSCLES OF THE BACK.

This has been recommended by M. Guérin, and according to his own assertion performed by him about *three hundred times*; either upon isolated muscles, as the rhomboid and levator scapula, in cases of elevation of the shoulder, or upon the mass of the sacro-lumbalis in instances of lateral curvature of the spine. After the operation he applies the apparatus for extension of the spine. He has had, however, but few imitators. In theory it would appear possible that those muscles which have much fibrous tissue in their composition, might fall into the same peculiar state of fixed shortening as observed in those which produce club-foot, yet the fact has not been so far verified as to render their division warrantable. In almost all cases of lateral curvature, we find on the convex side of the curve a rounded and firm mass of the erector muscles, which are believed by Guérin to be the ones in fault; but if the defect arose from muscular contraction of the rigid muscles, it would be more rational to expect to find them on the hollow side of the curve. Against the proposal of M. Guérin to divide them by a transverse section, it would be well to remember the great benefit that has been derived from a very opposite method of practice, that of carrying weights upon the head, so as to increase the action of all the muscles of the spine, as recommended by the celebrated English anatomist, Mr. Thomas Wilson, and the institution of gymnastic exercises which bring particularly into alternate action the masses of muscles upon the two sides of the spine.

TORTICOLLIS.—CAPUT OBSTIPUM.—WRY NECK.

This deformity is marked by a curvature of the neck, and an involuntary and permanent inclination of the head towards the shoulder of one side. There are several varieties of it.

1. It may depend upon the paralysis of the muscles of one side of the neck; the muscles of the opposite side, being unresisted by their antagonists, and acting with their usual force, then draw down the head upon the sound side, so as to produce the deformity. This variety, which is very rarely met with, may be readily distinguished by the following signs, viz.:—The head can be readily placed in its natural position without causing pain to the patient, but when we cease to retain it there, it falls again into its former twisted direction. The paralyzed muscles are flabby and inactive, and make no prominence in the neck. The treatment is that of palsy in general, but in case it should prove ineffectual, and the deformity go on increasing, the section of the sternal portion of the sterno-cleido-mastoid muscle of the sound side may be made with advantage in order to weaken the force of its contraction.

2. It may be produced by rheumatism of the neck, or simple inflammatory spasm of the sterno-cleido-mastoid, trapezius, or splenius muscles. The diagnosis of this variety is easy; there is pain produced on pressure which is augmented on motion of the parts, and some swelling and increased heat of the diseased side of the neck are usually noticed. The deformity in this case is produced

not so much by the increased contraction of the muscle at fault as by the pain which attends the effort to keep the head in a straight position. The disease usually lasts but a week or ten days. The treatment is leeching, fomentations, and the general management for rheumatism.

3. It may be owing to caries of the cervical vertebræ. The enlargement of the bones, the impairment of the movements of the cervical vertebræ, and the scrofulous tendency of the subject, then serve to establish an easy diagnosis. The treatment must be the same as that for caries in other portions of the spinal column.

4. It may be produced by a shortening or imperfect development of one or more of the muscles of the neck. It is this variety of torticollis, which has been called old or chronic, that constitutes the one most frequently met with in practice, and becomes properly the subject of operation. Its diagnosis is easily established. The position of the head will vary according to the particular muscle which is the cause of the deformity. If it be, as it is in a great majority of cases, the sterno-cleido-mastoid, the mastoid process of the temporal bone will be brought down toward the shoulder of the affected side, while the face, by a movement of rotation, will be turned toward the opposite shoulder. This position of the head is admirably shown in Plate LXXVII. If it be

the trapezius muscle that is affected, the position of the head will be distorted to a less extent, but nearly in the same direction, the back of the head being drawn down more directly upon the shoulder. In either case, the shortened muscle becomes apparent, as it forms from its superficial position a resisting cord or band below the skin. The deeper seated muscles of the neck and the platysma myoides, sometimes aid in producing the deformity, but they rarely become the subject of operation.

Treatment.—All internal medication has been found unavailing. By the long-continued use of orthopedic machinery, conjoined with liniments, we may sometimes succeed in cases where the deformity is not great, in gradually bringing the head to its proper position. It is upon the division of the shortened muscles, however, by a surgical operation, followed up for a time by the use of an apparatus for maintaining the head straight, that we can alone rely with any certainty for a cure. If the patient is under the age of puberty, we may, by these measures, in a great majority of cases, succeed in removing every trace of the defect. If he be older, and the deformity congenital, and attended, as it frequently is, with marked atrophy of the face and of the vertebral column on the diseased side, we may still effect the straightening of the head, but cannot, especially in individuals at the middle time of life, restore the symmetry and regularity

PLATE LXXVII.—SUBCUTANEOUS OPERATIONS.

TORTICOLLIS. (*Processes of M. Guérin.*)

Fig. 1.—*Torticollis of the left side. Section from before backwards.*—The head is secured by the two hands (*a, b*) of an assistant in the position in which it is thrown by the deformity. A longitudinal fold of skin is raised over the shortened sterno-cleido-mastoid between the hand of another assistant (*c*) and the left hand of the surgeon (*d*). At the period of operation shown the tenotomy knife is about to be entered at the base of the fold so as to be placed behind the muscle.

Fig. 2.—*Section of the sternal portion of the muscle only.*—The knife is shown introduced flatwise under the skin in front of the muscle.

Fig. 3.—*Section of both portions of the muscle from behind forwards*, by what is called the finger process, with a double-edged myotomy knife. The surgeon carries a fold of skin with the middle finger of the left hand (*a*) behind the muscle. He then introduces the double-edged knife flatwise through the skin at the posterior side of the muscle, with which it is kept closely in contact till the point strikes the finger. The finger is then withdrawn, the knife following it and piercing the skin a second time, but now in front of the muscle. The knife is then carried on till the second blade is lodged behind the muscle, the edge of which is then turned forwards and the muscle divided in the direction of the skin.

DIVISION OF THE RETRACTED TENDON OF THE BICEPS FLEXOR CUBITI. (*Process of M. Bouvier.*)

Fig. 4.—*Dissection of the elbow seen from the inner side of the arm.*—*a.* Biceps muscle: *b, i.* Tendon and aponeurotic expansion of the biceps. *c.* Triceps extensor cubiti *d, e.* Muscles of the fore arm arising from the condyles. *f.* Brachial artery. *g.* Median nerve. *h.* Profunda artery. *k.* Basilic vein. *l.* Median basilic vein. *m.* Cubital vein. *n.* Median cephalic vein. *o.* Cephalic vein. *p.* Vena communicans.

Fig. 5.—*Subcutaneous section of the tendon of the biceps*, in a case of permanent flexion of the fore arm corresponding with *fig. 4.* The puncture is made at the internal border of the tendon. The knife is held between the thumb and fore finger of the right hand—the three remaining fingers being made to press down so as to carry the brachial artery and vein and median nerve away from the tendon. The left fore finger is made in like manner to press away the parts from the outer side of the tendon, so as to cause the latter to stand up in relief. The knife is then introduced below the tendon, and made to divide it from below upwards.

Fig 1



Fig 4

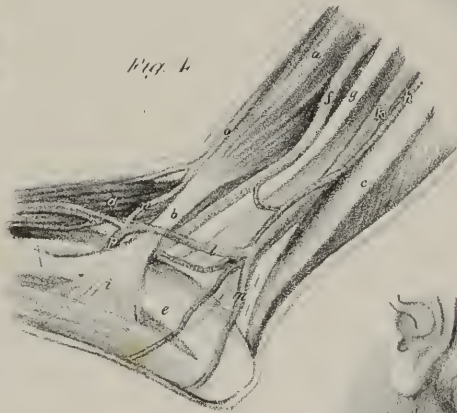


Fig 2



Fig 3



natural to the bones of the face and head. The muscle is to be divided by the subcutaneous process.

Surgical anatomy of the sterno-clavicular-mastoid muscle.—This muscle is surrounded in its whole length with important vessels and nerves, which it is necessary to avoid. In its upper third it is penetrated by branches of the spinal accessory nerve, and so involved with the cervical nervous plexus, that it cannot be divided there without injury to many nervous trunks. In its middle third it is crossed obliquely from above downwards and forwards by the external jugular vein and some filaments of the same nervous plexus. The division of this portion of the muscle incurs a risk of cutting the vein, a result, however, as the subcutaneous hemorrhage is quickly stopped, of not much importance in itself, and which may sometimes occur in the most approved operation when the vein is irregular in its distribution. But the muscle is not to be cut in this middle portion, for fear that the divided ends may so far recede from each other as not again to reunite, a result which has happened in the practice of Amussat. The lower third is selected as the place of operation in consequence of the distinctness with which it may be felt in the hollow above the clavicle, the smallness of its bulk, and the facility of acting separately either upon the sternal or clavicular portion of the muscle. The tendon of the muscle near its insertion upon the clavicle is crossed in front by some superficial veins; on its inner face, though separated from it by the thickness of the clavicle, lie the internal jugular and subclavian veins. An inch above the clavicle, the muscle is disconnected with any important part, the distance between it and the carotid artery being increased by the shortening of the muscle, which throws it out in relief, while the artery follows in the opposite direction the curvature of the bones of the neck.

Operation.—*1st process. Muscle divided from before backwards.*—The patient is to be seated upright in a chair, with his chest slightly flexed on the abdomen, and his head supported by the hands of an assistant, as seen in Plate LXXVII. fig. 1. Raising with the aid of another assistant, a fold of skin in front of the muscle, to facilitate which the head should be inclined to the diseased side, the surgeon seated in front takes the narrow bistoury or tenotome in his right hand if he operates on the left side, or in his left if the affection be on the right, makes a puncture about three-quarters of an inch above the clavicle at the external border of the tendon, and glides the blade in flatwise between it and the skin. He then turns the knife so as to press with the keen edge upon the tendon, the assistant at the same time rotating the head of the patient forcibly towards the healthy side, which makes the tendon tense, increases the distance between it and the deep-seated vessels, and renders it easily divided. The sensation of yielding in the muscle, the void space made by the separation of the divided parts, the want of resistance to the knife, and the facility with which the head can be turned to the opposite side, show when the division is complete, without the necessity of carrying the instrument down so as to endanger the deep vessels. The knife is then to be turned flatwise and withdrawn.

If the external jugular vein crosses the front of the muscle at the point for the subcutaneous incision, the knife must be insinuated between the vein and muscle, with the edge to the latter so as to avoid cutting the vein.

In many instances it will suffice to divide the sternal portion of the muscle only as shown in fig. 2.

2. *Division of the tendon from before backwards. Process of Dupuytren.*—This consists first in elevating the sternal edge of the muscle with the thumb and finger of the left hand, and making a puncture through the integuments and the platysma muscle with the bistoury, which should be held with its edge presenting upwards, and carried across the posterior face of the tendon, about three-quarters of an inch above the clavicle. The bistoury is then to be withdrawn, and along the track which it has cut another one with a probe-point is to be passed, for the purpose of dividing the tendon from behind forwards, without cutting the skin. The substitution of the second bistoury for the first renders the division somewhat less hazardous. The author has, however, effected it safely with the same instrument with which he has made the puncture.

Process of M. Guérin, (Pl. LXXVII. fig. 3,) denominated the finger process.—This is only applicable to cases in which the muscle is so free from adhesions on its posterior surface, as to allow a fold of the integument to be pushed across behind the muscle from its anterior to its posterior margin. When the end of the finger can be felt at the outer margin of the muscle, the double-edged knife of Guérin is to be entered. It should be held flatwise, entered through the integument at the clavicular margin of the muscle, kept closely in contact with the tendon, and made a second time to pierce the skin on the end of the finger. The finger is now withdrawn and serves as a conductor to the knife, which is pushed after it till the first blade projects through the skin, and the second blade is lodged under the tendon—the rounded portions of the instrument resting against the places of puncture. The edge of the second blade is then turned upon the tendon, which, by giving a sawing motion to the knife, is divided from behind forwards without injuring the skin. The knife is again turned flat and withdrawn. If any portion of the tendon is left uncut, the section may be completed with the first blade before the instrument is finally removed. The peculiar form of the knife of M. Guérin will be understood by reference to the Plate. This is a simple, ingenious, and comparatively safe process. If great caution be used in keeping the instrument close to the posterior face of the tendon, the division may be made with the ordinary long-bladed tenotome. In this way the author divided the sternal portion successfully during the past winter at the clinique of the Jefferson Medical College, and without making more than one puncture in the skin; the knife being passed upon the finger, between the sternal and clavicular portions, till the point could be distinctly felt through the fold of skin covering the finger, and then passed forwards as the finger was withdrawn, till it was fairly lodged behind the tendon to be divided.

In case the muscle was found closely tied down by posterior adhesions, the division of the tendon would be effected with more safety by the following than by either of the preceding processes.

Process of Roux.—A vertical incision is to be made through the skin and platysma myoides, over the middle line between the sternal and clavicular portions of the muscles. Each of these tendons is then to be separately denuded with the grooved director, raised upon this instrument, and separately cut by running the bistoury along its groove.

SUBCUTANEOUS SECTION OF THE TEMPORAL AND MASSETER MUSCLES IN CASES OF PERMANENT SPASMODIC CLOSURE OF THE JAWS.—(*Processes of M. Bonnet of Lyons.*)

The *Temporal Muscle* may be divided either above or below the zygomatic arch. The section below the arch would involve only the tendon of the muscle where it is surrounded by cellular tissue. It is not, however, always practicable at this place. An elongation of the coronoid process, as we see commonly in old men, raising its place of insertion above the zygoma—or the circumstance of one jaw moving within the other, renders it necessary to attempt the section above the arch—a process which is the least to be preferred as it is attended with the division of the two deep-seated temporal arteries, and does not allow the fibres to be completely separated from the coronoid process.

Section below the arch.—A strong, sharp-pointed, narrow knife, two inches long, is to be passed directly inwards below the malar bone, in front of the masseter muscle, and in a direction as if we were about to strike the tuberosity of the upper maxillary bone. As soon as this bone is felt, the direction of the knife is to be changed so as to pass from before backwards, between the external pterygoid and temporal muscle, till it comes in front of the articulation of the jaw. The cutting edge is then turned outwards, so as to divide the tendon of the temporal muscle. The operation is rendered more easy if the jaws admit of being a little separated.

Section above the zygomatic arch.—The knife is to be entered a little in front of the temporal artery, which may be felt anterior to the ear, and glided flatwise along in contact with the outer surface of the skull, as far as the posterior part of the malar bone. The edge is then to be turned outwards, and all the parts between the knife and the skin divided as the instrument is withdrawn.

SUBCUTANEOUS SECTION OF THE MASSETER.

This muscle cannot be divided in any part of the lower four-fifths of its course. In all this extent it is adherent to the jaws. It is, moreover, partially covered by the parotid gland, and crossed by the duct of Steno. The division should be made just below the zygomatic arch. A knife similar to that used for the temporal is to be entered immediately below the malar bone and in front of the masseter, taking care to puncture the skin opposite the internal face of the muscle. The instrument soon comes in contact with the coronoid process, and is to be carried on till it gets in front of the condyle of the jaw, or behind the masseter muscle, the posterior border of which may be readily felt; then, turning the edge outwards, all the parts are to be divided between the knife and skin.

The section of both masseters and the temporal muscle of one side was made in the case of a female fifty-two years of age affected with a closure of the jaws of ten years' standing. Some amelioration followed. These processes, though ingenious, cannot be considered established operations. I have, in several cases of ankylosis, divided the anterior half of the masseter from the cavity of the mouth, as described at page 247, and found this to suffice with the aid of the screw dilator of Heister, in enabling me to restore the motion of the jaw.

SUBCUTANEOUS SECTION OF THE VARIOUS MUSCLES OF THE FACE, FOR THE CURE OF SPASMODIC CONTRACTION.

Contraction of the muscles of one side.—Two cases have been reported in full of the successful treatment of this unsightly deformity, by the subcutaneous division of the affected muscles. The first of these, which occurred in the practice of Professor Dieffenbach, was a case of continuous vibratile contraction of the muscles of the right side of the face, the consequence of a rheumatic inflammation of the cheek, which had involved the trunk and branches of the facial nerve, and caused the angle of the mouth to be drawn round nearly to the ear.* The second case, reported in full by the author of this work, in the *Philad. Med. Examiner* for January, 1844, was that of a young man in whom the deformity, which was also on the right side of the face, had existed from early childhood, and was first noticed after an attack of measles. In this instance the right commissure of the mouth was drawn upward and outward upon the cheek. The deformity was still more increased by an attempt to smile or simply open the mouth, the commissure not only being further drawn backwards, but at the same time moved upwards or downwards, according to the muscles put in action, raising three concentric ridges upon the cheek. The left cheek was flattened, the patient having very little voluntary control over the muscles of that side. On attempting to draw the mouth towards its natural position, the muscles of the right side were thrown into strong contraction, and a slight tremulous motion only excited in those of the left. I performed the following operation somewhat after the manner of Dieffenbach, at the clinic of the Jefferson Medical College, (June, 1842,) for the purpose of weakening the action of the muscles of the right side, in order to give those of the left a chance of gaining such a relative increase of strength as to be able to bring the mouth into its natural position.

The patient was seated in a chair. On introducing my finger into the mouth, and causing him to attempt a smile, I found a roundish, rigid hardening of the muscles in three different directions—that of the buccinator—that of the zygomatici—and that of the depressor anguli oris. The orbicularis seemed also at fault, as it sunk the corner of the mouth inwards. Two subcutaneous incisions with a long and very narrow bistoury, straight on the edge, were made to divide these muscles. The knife was entered on the side of the mucous membrane, for the purpose of preventing the slight cicatrix, which might follow the puncture, from being visible. For the first incision, the knife was entered just above and in front of the entrance of the parotid duct, and pushed cautiously along the cutaneous surface of the mucous membrane in a direction parallel with the alveolar processes of the upper jaw, and for the extent of about two inches; the edge of the blade was then turned in front, and all the parts between the mucous membrane and skin divided as it was withdrawn. The zygomatic muscles gave way with a snap, and the buccinator was cut through the greater part of its origin from the upper jaw bone. The upper lip was next pushed outwards with the thumb and finger, and the knife, turned forwards as upon a pivot, divided the orbicularis oris through to the epithelium of the lip, without increasing the size of the puncture at the place of its entry. Four muscles were thus

* Vortrage in der Chirurgischen Klinik der Königl. Charité.

divided at one incision, as well as a portion of the fibres of the levator muscles. Considerable hemorrhage followed the withdrawal of the knife, though precaution had been taken to compress the facial artery. The blood filling up the line of the cut, gave an increased fullness to the cheek; the bleeding quickly stopped of itself, but little taking place externally, save as the knife was withdrawn.

The knife was then introduced, in like manner, from the inner surface of the lower lip just within the commissure, and carried obliquely downwards towards the angle of the jaw, and made to divide, as it was withdrawn, all the parts between the skin and mucous membrane up to the covering of the lip, consisting of the lower edge of the buccinator, the hard and rounded depressor anguli oris, and the lower disk of the orbicularis—the movement of the point of the knife being obvious below the skin in its whole course as it was retracted. But little bleeding followed this incision. The mouth, as was apparent to all the spectators, became immediately straight; nearly all power of motion over the right corner of the mouth was lost, while the patient regained considerable control over the left. A compress was secured with a nodose bandage over the facial artery. By means of a small silver hook in the left commissure, attached to a piece of ribbon, the mouth was drawn as far as possible to the left side, for the purpose of widening the subcutaneous incisions made on the right, and allowing them to fill up with a thick stratum of lymph, which, after the closure of the wound, was to insulate the divided portions of the muscles. The first incision only was much painful. The patient suffered afterward so little as to be unwilling to confine himself within doors.

By the third day the slight swelling and soreness of the cheek, which followed the operation, had almost entirely disappeared. On causing the patient to put into play the muscles of the right side of the face, it was found that none acted on the mouth, to produce deformity, but the middle undivided part of the buccinator, and the depressor labii inferioris of that side. A bistoury was introduced, as before, under the mucous membrane, and the middle part of the buccinator divided transversely, by a subcutaneous cut, about three-quarters of an inch from the commissure. The excessive traction of the corner of the mouth outwards at once ceased. The depressor still jerked the lip downward; but the division of it was deferred till the tenderness resulting from the former operations had disappeared.

More pain and soreness followed the last comparatively small incision, than attended the two former; serving to show the propriety of making all the necessary subcutaneous incisions in such cases, when possible, at one sitting, or waiting till every shade of inflammatory action has subsided before making a second cut. The inconvenience, however, was not sufficient to confine the patient to the house.

The operation was perfectly successful in removing every trace of the deformity, with the exception of an involuntary depression of the right margin of the lower lip in laughing. This, if it had been of sufficient importance, might readily have been removed by a section of the depressor labii inferioris muscle.

In cases similar to the two just referred to, it has been heretofore the custom, especially among the German surgeons, as well as in some cases of tic douloureux with convulsive twitching of

the facial muscles, to divide the trunk of the facial nerve. But the subcutaneous section of the muscles, offers at least an equal prospect of relief, without the same tendency to cause a permanent paralysis of the muscles, with a dropping of the lower lip, and retraction of the mouth to the opposite side.

Section of the orbicularis oculi.—In the case of Dieffenbach,* just alluded to, the convulsive contraction which this muscle shared in common with those of the same side of the face, was relieved by its subcutaneous section in several directions, with a knife introduced flatwise under the skin at the outer canthus of the eye. MM. Cunier and Phillips have, it is said, been equally successful in curing ectropion by a similar means, when this affection has supervened without inflammation and as a consequence of convulsions.

SUBCUTANEOUS SECTION OF THE TENDONS OF THE ARMPIT IN OLD DISLOCATIONS OF THE OS HUMERI. (*Process of Dieffenbach.*)

It is well known that the muscles in old dislocations become shortened in order to accommodate themselves to their new relations, and present subsequently powerful resistance to any attempt to replace the bone. This change is so readily effected, that even in dislocations of the head of the humerus of a month's standing the attempt at reduction by the ordinary process fails in more than a third of the cases in which it is undertaken, and when successful is sometimes attended by a rupture of some one of the tendons, or a laceration of some part of the muscular structure. With these views, Professor Dieffenbach has proposed—in cases of dislocation at the shoulder joint insusceptible of reduction by the ordinary means, and when moreover he is unable to rupture the resisting muscles by the methodical and sudden application of force—to divide their tendons by a subcutaneous incision immediately prior to the effort at reduction.

He resorted to this process in one instance where the dislocation was of two years' standing. The state of the patient, a man thirty years of age, was as follows. The right shoulder, which was the one affected, was an inch more elevated than the left. The acromion was very prominent under the skin. The supra and infra-spinatus muscles presented the appearance of two thin tense cords, in consequence of the permanent extension in which they had been so long placed by the dislocation and partial rotation of the head of the bone. The arm was emaciated, the elbow removed from the body, and the head of the humerus formed a visible prominence under the clavicle. The deltoid had lost its convexity in consequence of the head and neck of the bone being forced inwards. All these muscles could be distinctly felt under the skin, and seemed like hard, tense cords. Between the acromion and the outer curvature of the clavicle there were three broad, stiff bands, attached by one end to the clavicle and by the other to the humerus; these were adventitious productions forming a sort of capsule which retained the head of the bone in its new position. The movements of the arm were very limited, and depended chiefly upon that of the shoulder blade. The patient was placed on his back. The operator entered a small curved tenotome, (cutting only at the point,) under the skin at the anterior face of the shoulder, and carrying it up to the hollow of the arm-

* Chirurgie de Dieffenbach, par C. Phillips: Berlin, 1840.

pit, divided the supra and infra-spinatus muscles. The division of the muscles was announced by a snap. The patient was then turned upon his left side, and the knife introduced under the posterior border of the armpit to divide the tendon of the latissimus dorsi. This step was more difficult than the first, and attended by a small effusion of blood. The patient was again turned on his back. Determining with the fingers exactly the position of the head of the humerus, the knife was passed under the skin covering this region, so as to divide first the new capsule transversely over the head of the bone, and then by three lateral cuts the bundles or bands attached to the clavicle. The patient was then held by assistants, while the surgeon, grasping the lower end of the arm, rotated it at first upon its axis, and next by a circular sweep of the whole limb, in order to rupture the remainder of the adventitious attachments of its head. The separation of these was attended by a loud snapping sound. The patient was now laid on his back. Around his chest a strong bandage was placed, and drawn firmly from the opposite side. A counter-extending band was applied to the wrist to draw the head of the bone downwards, and another upon the upper part of the arm to remove it from the trunk.* These were given in charge to a number of assistants. The first attempt at reduction was now made, but without success. By augmenting farther the number of assistants, the bone was finally, and by the exertion of great force, brought back into its socket.

This practice of Dieffenbach has as yet found but few imitators, and is to be looked upon as another one of the doubtful movements in surgery, the propriety of which can only be determined by future observation. Even with the free use of the knife described, the force applied is violent, and therefore not unattended with danger. But it should also be recollected that serious consequences—fracture of the bone and even death—have followed violent attempts at reduction by the ordinary methods. Several fatal instances have been also reported, where, in the attempt at reduction, the axillary artery has been torn across in consequence of a preternatural attachment of its sheath to the displaced bone, the risk of which occurrence, though more or less diminished, would not be completely obviated by the section of Dieffenbach. How far the latissimus muscle after the division of the tendon would recover its power of action on the arm is not yet known; for this reason, and the acknowledged fact that the unreduced bone becomes in the end so movable in its new position as to restore a certain degree of usefulness to the arm, the surgeons of this country have been but little disposed to follow the Berlin professor. In the only instance within my knowledge in which the attempt has been made, the tendons of the pectoralis major and the latissimus were divided, (the former with no sufficient surgical reason,) but without advantage, as the bone was left unreduced.

SUBCUTANEOUS OPERATION FOR THE CURE OF EMPYEMA.

(Process of Guérin.)

M. Guérin employs a trocar with a stop-cock near the end. The patient is to be placed a little inclined upon the sound side. Having selected the point for puncture, the operator with the aid

* This is likewise the manner of employing force adopted by the same surgeon when he attempts to rupture the resisting muscles, in dislocations of two or three months' standing, which he is not able to reduce by the ordinary methods.

of an assistant, raises below this point a transverse fold of skin, an inch and a half to two inches high. Having ascertained that the base of the fold corresponds with the lower margin of the intercostal space to be punctured, he enters the trocar from below upwards through the skin and subcutaneous muscular structure, till the movement of its point can be felt in the depth by his left fore finger at the upper part of the base of the fold. The trocar is then to be passed slowly on through the intercostal muscles till the point moves freely in the pleural cavity. The assistant retains his hold of the fold of skin, while the surgeon, loosening his, with his left fore finger slides the skin like a sheath over the trocar so as to leave the latter covered from one and a half to two inches in extent, chasing out at the same time any portion of air that may have entered in the track of the wound. The stilet of the trocar is now withdrawn till beyond the site of the cock, which is to be turned to prevent the air from entering into the cavity of the chest.

The stilet is next removed entirely and a syringe screwed to the end of the canula. The cock is then turned so as to open the chamber of the canula, and the surgeon drawing out the piston fills the syringe with fluid from the chest. The cock is again turned to close the canula, and the syringe removed and emptied. The syringe is to be reapplied after this manner till the cavity is evacuated. The operation being terminated, the canula is to be withdrawn so as to prevent a single bubble of air from entering into the wound, in order to bring about a union without inflammation, as in other subcutaneous punctures. This is accomplished by making pressure upon the skin on each side of the canula, the left fore finger of the surgeon being applied above, and that of the assistant below, and as soon as the point is disengaged from the intercostal muscles, following it in its passage out by pressure with the end of the middle finger. Over the wound a piece of adhesive plaster is then to be carefully applied.

This process has been several times practised upon the living subject with success, at least as regards the operation. The chief objection to it is the necessity of repeating the puncture at every successive reaccumulation of the fluid. It may moreover be added, that when from the extension of the chronic pleural inflammation outwards, there is a pasty and thickened condition of the subcutaneous tissues over the intercostal spaces, it becomes impossible to raise the fold. This obstacle may be surmounted by passing the trocar obliquely up under the skin, and the necessity for frequent puncture obviated by forming a fistulous tract as in the author's operation, described at page 273.

PUNCTURE OF ABSCESES OR OTHER DEEP-SEATED COLLECTIONS OF FLUIDS BY THE SUBCUTANEOUS METHOD.

This process is so similar in its application to the one above described for empyema, that it will be only necessary to notice briefly the modifications required in different regions. If there is, for instance, a deep-seated abscess in the thigh, groin or back, or any other doubtful tumour, the surgeon may introduce with safety, by the subcutaneous method, the common exploring needle, or, which answers equally well, a small steel curved director, ground into a lance-shaped head at the point, either of which, by being very narrow, may be carried safely to a considerable depth, pro-

vided the great trunks of the vessels and nerves are avoided: the track left by the instrument healing like other subcutaneous wounds by first intention. By this means the surgeon acquires a knowledge of the interior of the tumour, whether it consists of one or many cavities, and is enabled to judge of the quality of its contents by the little amount of fluid that oozes along the groove of the instrument. If the quantity of fluid is but small, it may in this way by the aid of pressure be completely discharged; if on the contrary it should be found large, the trocar and syringe may be used as directed for empyema.

In scrofulous abscesses; in which there is a strong tendency to reproduce the secretion, many punctures may in this way be required, and if properly done, and made through healthy integuments, the operator may confidently expect, in general, that the wounds will heal as in other subcutaneous operations. The condition of the patient may by this means be greatly ameliorated; time is gained for the administration of appropriate general remedies, and the abscess at each successive puncture becomes smaller and smaller, till at last no more pus is formed than the recovering energies of the system will be capable of removing by absorption. This practice of Guérin, which is but an improvement on the valvular puncture of Abernethy, though not applicable to all cases of abscess, will be found to afford occasional facilities in practice, of which the judicious surgeon will know how to avail himself.

SUBCUTANEOUS SECTION OF MUSCLES, TENDONS, AND FASCLE FOR THE CURE OF DEFORMITIES OF THE LOWER EXTREMITIES.

TALIPES, OR CLUB-FOOT.

Talipes having been adopted by several late writers as the generic appellation for deformities of the foot, it will be employed in this article synonymously with club-foot. There are four principal varieties of this affection, which are here enumerated according to the frequency of their occurrence—*Talipes varus*, *Talipes equinus*, *Talipes valgus*, and *Talipes calcaneus*. A fifth variety occasionally met with has been distinguished by M. Guérin as *Talipes plantaris*.

These several varieties are more or less susceptible of being combined together, so as to establish certain deformities of a mixed or complicated character, which form by far the most numerous class of all. The anatomical characteristics of the different varieties are briefly given below.

Talipes varus. (*Pes varus.*)

This species of deformity depends upon a forced abduction of the foot inwards, with an elevation of the internal border, the plantar surface facing directly inwards. (Pl. LXXVIII. fig. 4.) Most commonly we find in practice, conjoined with it, more or less elevation of the heel, complicating it with talipes equinus. (Pl. LXXVIII. fig. 3.)

The *scaphoid bone*, which, in a well-formed foot, is placed at the internal margin of the dorsal surface, is found rotated from within outwards on its smaller axis, so as to have its internal border placed obliquely near the internal malleolus, while its external tuberosity is placed transversely on the back of the foot, looking

downwards. In consequence of this rotation, the internal border of the foot forms an acute angle with the internal malleolus, and the outer two-thirds of the head of the astragalus leaves the cavity of the scaphoid bone.

The *os cuboides* undergoes a similar rotation, so as to form at its place of articulation with the head of the *os calcis* an angle, obtuse outwards and acute inwards, consequently leaving uncovered, so as to be felt on the outer side through the skin, a portion of the articular face of the anterior tuberosity of the latter bone.

The *os calcis* is also changed in its position, so that its anterior tuberosity presents more or less downwards, while its posterior tuberosity is turned to an equal extent inward and upward, the calcis being thus semi-luxated at its articulation with the astragalus. The ligaments which join the calcis to the cuboides are found generally in a state of great relaxation. The anterior tarsal and the metatarsal bones are usually deviated in like manner upon those to which they are articulated, the toes being thrown in a vertical line with the greater one projecting upwards, rendering the dorsal surface of the foot very convex. From the general twisting of the foot, the inner margin of the heel is also thrown upwards to near the internal malleolus, and turned backwards so as to bring the external malleolus near the surface of the ground, the weight of the body being sustained on the external border, which in course of time, from the pressure to which it is subjected, gets covered by a thick and hardened corn, underneath which we find frequently developed an adventitious bursa mucosa converting the corn into a large bunion, the serous membrane of which, when inflamed, becomes exceedingly painful, and is sometimes found in the state of suppuration. All the bones of the foot, if examined in a person in middle life, will be found more or less in a state of atrophy, and in some few instances of congenital club-foot, the astragalus has been observed twisted on its axis, and disproportionately lengthened. The twist of the foot gives a tendency to rotation of the leg inwards, producing in the end more or less deformity at the knee joint, which contributes to impair the uses of the limb in station and locomotion.

The *ligaments* undergo changes corresponding with the altered position of the bones. The deltoid or internal lateral ligament of the ankle joint is shortened, while the external lateral ligaments are lengthened. A new band of fibres or accidental ligament is often found tying the malleolus internus to the *os calcis*. The inferior calcaneo-scaphoid ligament is shortened, and tends to keep up the mal-position of the foot, while the superior calcaneo-cuboid, in accordance with Scarpa's observation, is found materially lengthened.

Muscles and tendons.—The leg is thin, in consequence of the atrophy of the muscles, and their tendons are commonly smaller and longer than usual. In some few instances, some of the muscles, the *gastrocnemii*, for instance, are spasmodically contracted into a firm ball, as in cramp, while their tendons are thicker and stronger than natural; and these cases, judging from my own experience, will prove the most difficult of management. While one set of muscles—the anterior and posterior tibial, the *gastrocnemii* and the flexor of the toes—is found shorter than usual, their antagonists, forming a second set, will be found correspondingly lengthened, and these, though in the commencement presenting some opposition to the production of the deformity, may in the

end have their tendons, as they pass over the back of the foot, so displaced as to contribute to the distortion. The tendo-Achillis, which is inserted behind and a *little to the inner side* of the os calcis, has, by the twist of this bone, its natural obliquity of insertion augmented, and the shortening of the muscle tends, in proportion as the foot is abducted, to draw the calcis more and more upwards and inwards; serving thus completely to explain the common complication of talipes equinus with advanced cases of talipes varus, sometimes designated as the *varus equinus*.

The articulations are usually found mobile, and may even with the pressure of the hands be put straight in children. But as persons advance in life, by continual pressure in walking, or from the use of ill-contrived apparatus, they become more or less rigid and immovable.

In this variety it may frequently be necessary to aid the use of machinery in straightening the part, by dividing the tendo-Achillis. The section of this tendon alone will in most cases suffice; though in some instances it has been deemed proper to cut the tendons of the anterior and posterior tibial muscles and the plantar aponeurosis.

2. *Talipes equinus.* (*Pes equinus.*)

This variety of the deformity exists at various degrees between a slight deviation of the foot from the horizontal position, to the extreme degree in which it is brought nearly into a straight line with the leg, the metatarsus projecting downwards. Its worst forms are almost always acquired. In its uncomplicated state it is produced by the shortening of the gastrocnemii muscles. (Pl. LXXVIII. fig. 3.) The position of the toes varies. They are commonly placed in permanent extension; but they are occasionally found flexed.

Bones.—The astragalus is always more or less luxated forward and downward, so that a portion of its tibial surface may be felt out of the mortise on the back of the foot. In cases of extreme deformity the whole of the upper articular surface of this bone is turned forward, so that the tibia and fibula rest only on the back

part of the astragalus and the upper surface of the calcis, as I have had opportunities of observing upon dissection. In these cases the posterior part of the articular surface of the astragalus is rendered flat by the pressure of the bones of the leg, while the front portion, no longer subjected to pressure or lubricated with synovia, becomes roughened and covered with bony deposit, so as to offer an almost insurmountable obstacle to anything like a perfect cure of the deformity. The whole structure of the foot is found, as it were, twisted from before backwards, the tarsal bones as a consequence being separated on their dorsal face, and compressed on their plantar. The ligaments undergo corresponding changes; they are lengthened and thinned above, and shortened and thickened below.

In its simple state, talipes equinus can require the division of no other part than the tendo-Achillis. In case the toes, as before mentioned, are in addition strongly extended or flexed, *it may be* desirable to divide their extensor or flexor tendons. If the pes equinus is complicated with an inclination of the sole inwards, so that the weight of the body is borne on the external border, we have a sub-variety which has been denominated the *equin varus*. If the opposite border of the foot is elevated, and the sole presents outward, the modification of the deformity is known as the *equin valgus*. It is seldom, however, that the tendons of the muscles which produce these subsidiary displacements require to be cut, the division of the tendo-Achillis usually enabling us, by the aid of proper machinery, to readjust the foot as completely as the change of structure in the bones will allow. In cases of moderate distortion, proper extension of the muscles without section of the tendon will suffice.

3. *Talipes valgus.* (*Pes valgus.*)

The characteristic features of this variety of club-foot are just the reverse of talipes varus. The external border of the foot is raised, and the internal applied upon the ground. The heel is drawn outwards, the internal malleolus is very prominent and thrown forwards. The internal border of the foot is convex, and

PLATE LXXVIII.—SUBCUTANEOUS OPERATIONS.

CLUB-FOOT.

Figs. 1, 2, 3.—Talipes equinus.—Fig. 1 represents the character of this deformity. Fig. 2 shows the first step of the operation for dividing the tendo-Achillis. The patient is laid on the abdomen. The two hands of an assistant (*a, b*) grasp the foot and extend it on the leg. The surgeon then with the aid of another assistant raises a fold of skin over the tendon, in the manner shown in Plate LXXVII. fig. 1, introduces the knife flatwise through the skin, and carries it over the posterior surface of the tendon. At the moment of operation shown, the surgeon has turned the edge on the tendon for the purpose of dividing it as the assistant strongly flexes the foot. In fig. 3 is shown the immediate result of the division of a contracted tendo-Achillis on the dead body. A flap of skin has been dissected away, and the fibrous sheath of the tendon split open and drawn outwards by two hooks (*a, a*). The position of the knife (*b*) is shown after the division of the tendon and the straightening of the foot. The space left between the ends of the tendon is made chiefly by the descent of the lower portion which follows the depression of the heel.

Fig. 4.—Talipes varus.—Section of the adductor muscle of the great toe, in a case where there was a strong retraction of the internal border of the foot. The hand (*a*) of an assistant presses the heel outwards. The surgeon carries the toes in the same direction with his left hand (*b*), and with his right (*c*) introduces the knife flatwise between the skin and the muscle, and then divides the latter downwards in the direction of the scaphoid bone.

Fig 3

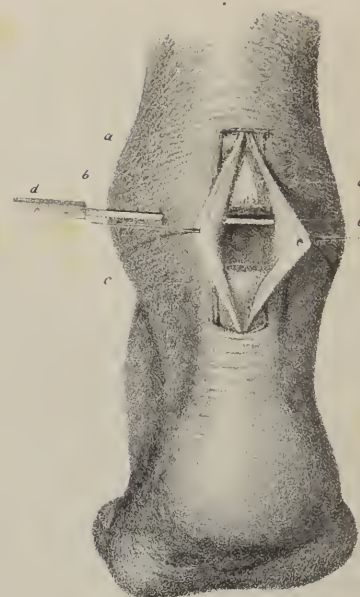


Fig 4



Fig 2

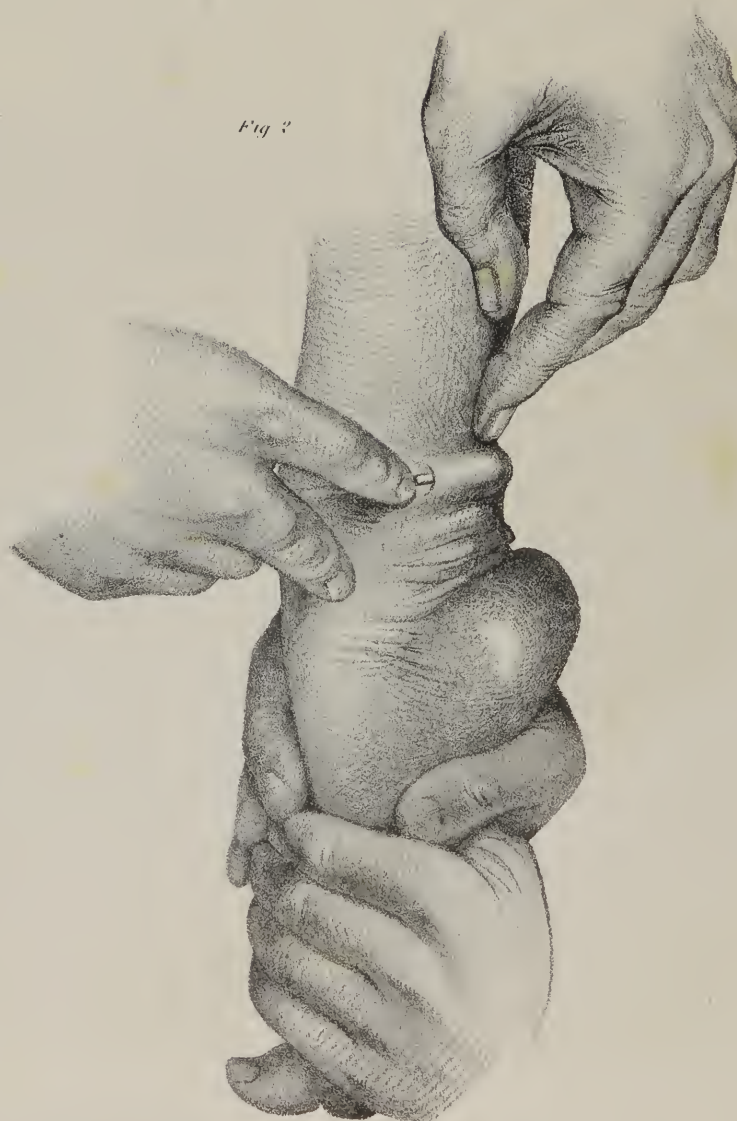


Fig 1



the outer concave, the centre of the concavity existing at the articulation between the calcis and the os cuboides. The shortened plantar surface of the foot is marked by numerous and deep sulci. In this variety of club-foot, which is but rarely met with, the use of the foot in walking is rendered very unsteady and fatiguing. The contraction of the three peronei muscles is considered the cause of this deformity. They yield, however, in almost every case, to mechanical distension. Very commonly we find the talipes valgus complicated with an elevation of the heel, from the contraction of the gastrocnemii, (forming what has been called by M. Guérin, the *valgus equin*;) and in such cases the section of the tendo-Achillis has been frequently practised.

4. *Talipes calcaneus.* (*Talipes talus.* *Pes calcaneus.*)

This is the most rarely met with of all the varieties of club-foot. The foot is placed in a position just the reverse of that in which it is found in talipes equinus. The metatarsus and toes (which are usually found atrophied) are drawn upward, while the heel, which is large and thick, is depressed. The cause of the displacement is found in the contraction of the tibialis anticus, extensor digitorum, and extensor pollicis pedis muscles; the tendons of which, if they are not found to yield to continued mechanical distension, it will become necessary to divide.

5. *Talipes plantaris.*

This last variety of club-foot, recently described by M. Guérin, consists of a deformity produced by a shortening of the muscles on the plantar surface of the foot, which diminishes the length of the organ, and causes a marked increase of the convexity of the dorsal surface inwards or outwards, causing the complications which he has denominated *planti-varus* and *planti-valgus*.

From this general description it will be observed that some one or more of all the muscles of the leg and foot are found permanently contracted or shortened in connection with some one of the several varieties of club-foot, while the sets of muscles antagonizing those affected, are found in a proportionate state of elongation. Many of these cases, as before observed, are susceptible of cure or great alleviation, by the stretching of the contracted muscle by machinery alone, or with the assistance afforded by the section of one or more of the tendons. In the more aggravated cases there are, however—a fact in which something analogous may be observed in most other surgical affections—limits to the means of relief afforded, in consequence of the alteration in the structure of the bones, ligaments and joints. On the other hand, the muscles which have been elongated in the deformity, are frequently left so atrophied and weakened, as not to retain sufficient power even after the foot has been put straight, to prevent its relapsing more or less towards its deformed position, when, after the cicatrization of their tendons, the primitively retracted muscles have begun again to act. This tendency to secondary retraction is strong and long continued, and is more apt to show itself, as would naturally be expected by all who are familiar with the retractile properties of other newly-formed tissues, after the cure of a deformity in which the knife had been used, than in those milder cases in which it can be accomplished by machinery alone. With these views I have considered it necessary, in my own practice, to keep up mechanical extension continuously or at intervals, for several

weeks or months, even after the cure appears complete, and not to consider it perfect until all tendency to relapse had ceased.

After these prefatory remarks in regard to the indications for the subcutaneous sections of tendon for the cure of club-foot, the processes for dividing the individual tendons and fascia will be briefly described.

SUBCUTANEOUS SECTION OF THE TENDO-ACHILLIS.

Surgical anatomy.—The tendo-Achillis is the strongest tendon in the body, and the one most frequently divided in the treatment of club-foot. It is placed in the middle line of the back part of the ankle joint, enclosed in its own particular fibrous sheath, and covered externally by the posterior aponeurosis of the ankle joint, which is usually found but little resistant in the class of deformities under notice. A layer of fatty cellular tissue covers it in front and upon the sides. Between it and the external malleolus, but in close contact with the latter, and bound down in their fibrous sheaths, lay the tendons of the peronei muscles. Between it and the internal malleolus are lodged the tendons of the flexor longus pollicis, the flexor communis, the tibialis posticus, and the posterior tibial artery and nerve. The last two lie in the healthy state about midway between these points, though rather nearest to the malleolus; but in the retracted state of the tendon, their distance from the latter is still further increased, so as to be, in the adult, notwithstanding they are rendered incurvated by the contraction of the foot, wholly out of the way of the knife; and in children, where the prominence of the tendon is less manifest, they may be readily avoided by the exercise of a little care. The tendons of the muscles are close to the malleolus, and like the artery and nerve bound down by an aponeurotic covering. The tendo-Achillis may be divided at any point between the distance of one and three inches above the os calcis. The distance of an inch to an inch and a half, in the adult, is the one usually preferred, as the tendon is there found least in diameter.

Operation.—The section may be made by entering a narrow straight-bladed knife below the tendon, and cutting outwards; or which is decidedly preferable, by inserting it between the skin and tendon, dividing the latter in the opposite direction. The patient, if a child, is placed on the abdomen; if an adult, he may rest with his knees on a chair or sofa. The foot is to be grasped by the hands of an assistant. A vertical fold of skin is then to be raised, with the aid of another assistant, over the tendon, and the knife or tenotome entered flatwise at its base. When the knife is passed so as to reach the opposite side of the tendon, the hold of the fold is loosened, and the surgeon places his fore finger on the tendon so as to direct the blade. The knife is next to be turned edgewise on the tendon, as shown in Plate LXXVIII. fig. 2. The assistant now firmly flexes the foot, and as the heel is brought downwards, the tendon rises against the knife, which should at the same time be a little depressed, in order to divide the tendon completely across. The posterior portion of the sheath of the tendon is necessarily cut—the anterior lies before the edge of the knife so as to escape division. The lower portion of the divided tendon then follows the heel, and the foot, in favourable cases, is put at once in the position shown at Plate LXXVIII. fig. 3. If the anterior part of the sheath of the tendon is so hard and unyielding

as to prevent the descent of the heel, and offers resistance to the finger when pressed over the line of the wound, it becomes necessary to divide it also. This is accomplished by depressing the point of the knife, a part of the operation which should be done with caution, for fear of injuring the neighbouring vessel and nerve. The knife must be withdrawn with care so as not to enlarge the orifice of the wound. The section is frequently unattended with any effusion of blood, the little that escapes from the sides of the cut lodging in the cavity left by the separation of the two ends of the tendon.

It is advised by MM. Velpeau, Bonnet, and Mr. Whipple, to make the section of the tendon always from its inner side, to avoid the risk of wounding the artery by too great a depression of the point of the knife, employing, according to the foot operated on, either the right or left hand. This is not, however, if ordinary care be used, a matter of great importance, as it will answer on the right foot to enter the knife on the outer side, in order to allow it to be held in the right hand. Some surgeons prefer to hold the foot always with their own hand, in order to harmonize more completely the movement of extension with the introduction of the knife, and that of flexion with the section of the tendon. But by this arrangement they lose the advantage of raising a previous fold of skin over the tendon, which allows of the puncture being made at a greater distance from the latter. In order to avoid all risk of making a counter-puncture of the skin, MM. Bouvier and Bonnet advise a simple puncture at the base of the fold with a lancet-shaped knife, and the subsequent introduction of a blunt-pointed tenotome. Dieffenbach employs a narrow sickle-shaped knife, which he carries at once between the skin and the tendon, and pushes up the latter with the thumb of the left hand, so as to divide it completely as he withdraws the instrument. Scoutetten introduces his knife below the tendon, and cuts from within towards the skin.

After the division of the tendon, even in the first or second degree of club-foot, it must not be expected that the foot will resume at once, or jump, as it were, into its natural position. The cure must be attended by two different results. 1st. The separation of the ends of the divided tendon, and its absolute elongation by the interposition of the new tendinous structure. 2d. By the removal of the permanent spasmodic tension of the muscle, so as to allow the blood to enter more freely into its structure, and enable it to yield to the mechanical measures for its elongation. The combined agency of these two results I have often seen manifested in the cure of bad cases of club-foot, when the heel has in the end been made to descend to the extent of four or five inches, while the newly-formed tendon was left only an inch in length.

If the heel cannot be brought down at once after the complete section of the tendon, the cause, if it lay in the distorted end of the astragalus hitting against the upper edge of the ankle joint, may often be removed by gentle and well-directed efforts upon the foot; but if it be found in some resisting and prominent tendon which has given a varus or valgus inclination to the foot, it will be best at once to divide it. In these cases of complicated club-foot, many surgeons, though as it appears without sufficient reason, even prefer to overcome the lateral deformity before they make the section of the tendo-Achillis.

SECTION OF THE ADDUCTOR MUSCLE OF THE GREAT TOE. (PL. LXXVIII. Fig. 4.)

This muscle it is sometimes requisite to cut in highly marked cases of talipes varus. Under such circumstances it forms a prominent hardened band when an attempt is made to straighten the curve of the foot. There are no anatomical points of importance concerned in the operation. The foot should be held as seen in the drawing. The surgeon with his left hand extends the toes, and with his right makes a subcutaneous section of the muscle over the scaphoid bone, before its junction with the short flexor muscle of the toe. The limb is to be sustained as shown in the drawing.

SECTION OF THE TENDON OF THE ANTERIOR TIBIAL MUSCLE.

This, of all the tendons of the foot, with the exception of the tendo-Achillis, is the one that has been most frequently divided. Its section has chiefly been advised in cases of talipes varus. In most instances, however, it has been done very unnecessarily, and *is rarely ever called for* when the point of the foot can be elevated after the section of the Achillis tendon, for by this movement the muscle is placed in a state of relaxation without the use of the knife. When it really offers an obstacle to the descent of the elevated inner margin of the foot, not readily overcome by machinery, the tendon forms an obvious prominence on the side of the foot. The division is to be made at the place where the projection is the greatest, which is usually found exactly in front of the ankle joint. The section may be made by introducing the knife under the tendon and cutting from within outwards, or by previously raising a fold of skin in the usual manner, (the ankle being flexed,) introducing the knife above the tendon, and dividing it from above downwards while an assistant draws upon the foot to place it in the state of extension. In this mode of operation care must be observed not to allow the knife to descend so low as to wound the ligaments of the joints. The only part much endangered in this operation is the anterior tibial artery, the position of which should be carefully determined beforehand. In the cases in which it is necessary to cut the tendon, I prefer to do it by the former process, introducing a curved knife between the tendon and the artery, so that all risk of injuring the latter is obviated. If it be preferred, the tendon of the anterior tibial muscle may be divided near its insertion upon the cuneiform bone, but the operation is not here so easy of performance.

SECTION OF THE TENDON OF THE POSTERIOR TIBIAL MUSCLE.

The section of this muscle is seldom required except in complicated cases of club-foot, where the scaphoid bone is drawn round, so that its anterior end is nearly in contact with the internal malleolus. To make a neat section of this tendon without injuring the surrounding structures, requires more attention on the part of the operator than the division of any of the other tendons of the foot. It is placed against the posterior face of the malleolus internus in a solid fibro-osseous canal, just behind the tendon of the long flexor of the toes and in front of the posterior tibial vessels and nerves, but so near the latter that to avoid wounding them, its

section at this point must be made with care. M. Velpeau has directed that it should be divided lower down—near its insertion on the scaphoid bone. But this project is also attended with danger from the same causes, as well as from a new articulation formed here by the distorted joint in cases of strong inversion of that bone—the only circumstance which it appears to me can render the operation at all necessary. The division is, therefore, in the greater number of cases, to be made at the posterior and internal angle of the tibia *just above the malleolus*, where it will be found tense, though not very prominent, in consequence of its being confined in its groove. The division should be made from within outwards. One assistant steadies the leg; another grasps the foot with both hands so as to extend and abduct it. The surgeon introduces the nail of the left fore finger between the tendon and the posterior tibial vessels and nerve, so as to separate the tendon from the latter structures, and at the same time roll it forwards and inwards and fix it against the tibia. A slightly concave bistoury is then passed from before backwards under the anterior face of the tendon and next the bone till the point is felt under the nail. The handle of the knife is then to be depressed and the tendon severed. Care must be observed that the point of the knife does not pass beyond the nail, for fear the artery should be injured. In case it should be deemed necessary to divide the tendon of the flexor of the toes and that of the posterior tibial muscle, both may be cut at the same operation. The limb should then be disposed as directed above, and the knife carried between the skin and the tendons till it is felt in contact with the nail upon the other side. The edge is then to be turned directly upon the bone, so as to divide completely both tendons as it is withdrawn.

In case it is preferred to make the section *below the malleolus*, the operation is to be performed in the following manner. Having ascertained the position of the head of the scaphoid bone, the point of the knife is to be entered a third of an inch above it and a little in front, till it comes in contact with the astragalus. It is then to be slid in contact with this bone till its point may be felt under the skin about the sixth of an inch below the lower margin of the scaphoid bone. The tendon is now over the blade, and by depressing the handle and turning the edge upwards, may readily be cut. The common flexor muscle of the toes, which is here found behind the posterior tibial, is liable to be wounded by this process—but the artery incurs no great risk of injury if proper caution be observed.

SECTION OF THE TENDONS OF THE COMMON FLEXOR MUSCLE OF THE TOES.

The proximity of the common tendon to the posterior tibial artery behind the malleolus, and its deep situation in the posterior part of the sole of the foot, have induced orthopedic surgeons, in all cases except the one just mentioned, to attempt its division only at the anterior part of the sole of the foot, near the roots of the toes. Its section is only called for in cases of extreme and permanent flexion of the toes, when at the place last mentioned the four branches into which the main tendon is divided will be found prominent and obvious. As there is considerable space between the divaricating tendons, four separate punctures are required. The division will be made after the

union of the short with the long flexor tendons, an object rather desirable than otherwise, as it is sometimes difficult to tell in advance to which of the two muscles the contraction is owing. A curved sharp-pointed bistoury is to be passed down by the side of each one of the four tendons till it strikes the root of the first phalanx; it is then to be glided between the tendon and the bone, and the handle depressed so as to divide the tendon as the blade is withdrawn. Some of the collateral arteries, in this operation, run a risk of being injured, but in a subcutaneous section of this sort their division would be a matter of no moment.

SECTION OF THE PLANTAR APONEUROSIS AND SHORT FLEXOR OF THE TOES.—(PL. LXXIX. FIGS. 3, 4.)

This is sometimes rendered necessary in complicated cases of *talipes equinus*, when from the permanent contraction of this muscle, and the aponeurosis plantaris, the toes and heel have been approximated. An assistant grasps the extremity of the foot, and the surgeon takes hold of the heel with the left hand so as to straighten the curve of the foot as much as possible, and render the muscle and aponeurosis tense. He then enters the knife at the inner margin of the foot, and having passed it flatwise directly across beneath the skin, turns the edge downward, so as to divide the tense cord which is formed across the sole, until the resistance to the straightening of the foot has in a great measure ceased.

The point selected for the section is that where this fibro-muscular cord stands out most in relief. This is usually on a line with the junction of the os calcis with the os cuboides. There is no positive limitation here as to the extent of incision, except the cessation to the resistance, from the division of the contracted part. But even should the knife descend to the articulation, (which is not necessary, however,) provided it did not injure the ligaments, no serious injury would follow, as there is not, immediately below the contracted part, any important vessel or nerve. There is always, after the section of the short flexor and the aponeurosis, some little effusion of blood, but this is readily checked by compression.

SECTION OF THE TENDON OF THE LONG FLEXOR OF THE GREAT TOE.—(PL. LXXIX. FIG. 2.)

In cases of *talipes varus*, complicated with excessive contraction of the great toe, the division of the tendon of the flexor longus pollicis may, in some few instances, be attended with advantage. The division has been made along the internal border of the foot, by Stromeyer and Dieffenbach, where it probably formed, though not so stated by these surgeons, a marked projection. But in this region, the tendon is so near to the internal plantar artery and nerve, that these must run some risk of injury in the operation. Immediately behind the metatarso-phalangeal articulation, or over the first phalanx of the great toe, the section, as practised by Prof. Syme, of Edinburgh, may be made with ease and safety. The toe is to be straightened out by an assistant; the operator then passes a knife under the skin from the inner border of the foot, and turns the edge upon the tendon so as to divide it from without inwards.

SECTION OF THE TENDONS OF THE TWO LARGER PERONEI MUSCLES.

The division of one or both of these tendons has, in some few instances, been deemed necessary in cases of talipes valgus and talipes talus, with marked eversion of the sole of the foot. The tendons are firmly bound down, and therefore do not rise up to any great extent, when the muscles are spasmodically contracted. The two tendons are found together on the external face of the fibula; pass in a deep groove behind the external malleolus; and are inserted:—the peroneus secundus on the posterior extremity of the fifth metatarsal bone—the peroneus primus on the first metatarsal, after having passed obliquely across the plantar surface of the foot. Behind the malleolus the groove in which they are lodged is so deep that they cannot be divided with facility. When it is desirable to sever both at one cut, the operation should be done above and a little behind the malleolus. If it be wished to divide the peroneus secundus alone, the puncture should be made near its insertion on the fifth metatarsal bone, after the separation of the two tendons.

Section of both tendons above and behind the external malleolus.—The foot should be rested on the inner side of the heel. An assistant grasps it at its extremity, so as to be ready to lower its outer border. The operator with the fore finger of the left hand confines the tendons against the fibula, while he insinuates a knife between them and the skin, and divides them both by a single cut down upon the bone.

Division of the tendon of the peroneus secundus below the malleolus and above the cuboid bone.—The hands are to be placed precisely as in the process just described, except that the fore finger of the left hand of the operator is brought down upon the tendon near its point of insertion. The knife is to be entered near the dorsal edge of the tendon, and passed directly across it towards the outer margin of the foot. The division is made from above downwards, upon the bone. Velpeau has proposed to divide the tendon of the peroneus longus in the space which separates the end of the malleolus from the external tubercle of the os cuboides.

SECTION OF THE EXTENSOR MUSCLES OF THE TOES.

In that very rare species of club-foot known as *talipes calcaneus*, the common extensor muscles of the small toes and the

proper extensor of the large, are the immediate causes of the deformity. The distortion is commonly increased by the accessory contraction of the tibialis anticus, and not unfrequently by that of the flexor brevis on the sole of the foot.

The division of the common extensor is to be made at the point at which it is most prominent—either in front of the annular ligament of the ankle joint, or just behind the metatarso-phalangeal articulations, if it be a case of simple extension of the toes. The process to be followed is much the same as for the division of the other superficial tendons. The common extensor may be divided below the annular ligament from above downwards;—the proper extensor of the big toe is placed so closely in contact with the anterior tibial artery, that it is much safer to enter the knife between it and the vessel, and divide it from within outwards. The latter tendon is situated so near that of the anterior tibial that the two, *when necessary*, may be divided together.

SECTION OF THE TENDONS AND OTHER FIBROUS STRUCTURES FOR FALSE ANCHYLOSIS OF THE KNEE JOINT.

False ankylosis of the knee in the bent position, is distinguished from the true or bony in consequence of its admitting of more or less movement of the leg backward. The employment of tenotomy in angular deformities of the knee joint, has not been attended with results so beneficial as in the treatment of club-foot. In at least fifteen out of twenty cases that present themselves, the affection will be found the consequence of inflammation in the osseous or ligamentous structures of the joint. In the other fourth, some of the cases will be found owing to a rachitic alteration in the form of the articular surfaces, and the remainder only may be set down as dependent upon an active contraction of the flexor muscles of the leg and the aponeurotic membranes and ligaments about the joint. Even in this last class of cases, which alone has any analogy with the contraction in club-foot, the deformity is rarely ever congenital; it mostly occurring in consequence of the flexed position in which the joint is allowed to rest in some of the chronic affections to which different parts of the limb are subject. It is to cases of this description, when the affection has been of some months' standing, and not easily redressed by machinery or the use of the hand, that tenotomy has been found applicable. When the deformity is of many

PLATE LXXIX.—SUBCUTANEOUS OPERATIONS.

CLUB-FOOT.

Figs. 1, 2.—Talipes varus.—*Fig. 1* represents a case of simple varus in a young child.—*Fig. 2*, a case of varus complicated with retraction of the flexor tendons, and especially of that of the long flexor of the great toe, the process of dividing which is shown. The toes are extended by the hands (*a, b*) of an assistant; the surgeon has introduced the knife at the inner border of the foot, and is about to turn the edge downwards to divide the tendon.

Figs. 6, 7.—A complicated case of club-foot.—The heel is drawn upwards as in talipes equinus, and the anterior extremity of the foot bent downwards towards the heel. A lateral view of the foot is given in *Fig. 3*. The process for the division of the plantar aponeurosis and the short flexor muscle of the toes is seen in *Fig. 4*. The toes are extended by the hands of an assistant (*a, b*). The surgeon grasps the heel with his left hand (*c*), and introduces the knife between the skin and the aponeurosis with his right (*d*).

Fig 3

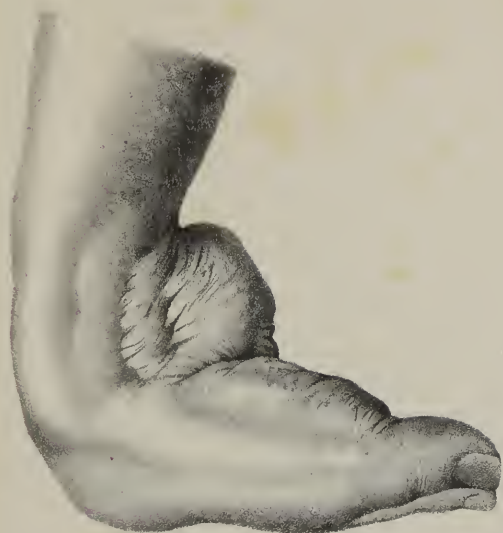


Fig 4



Fig 2

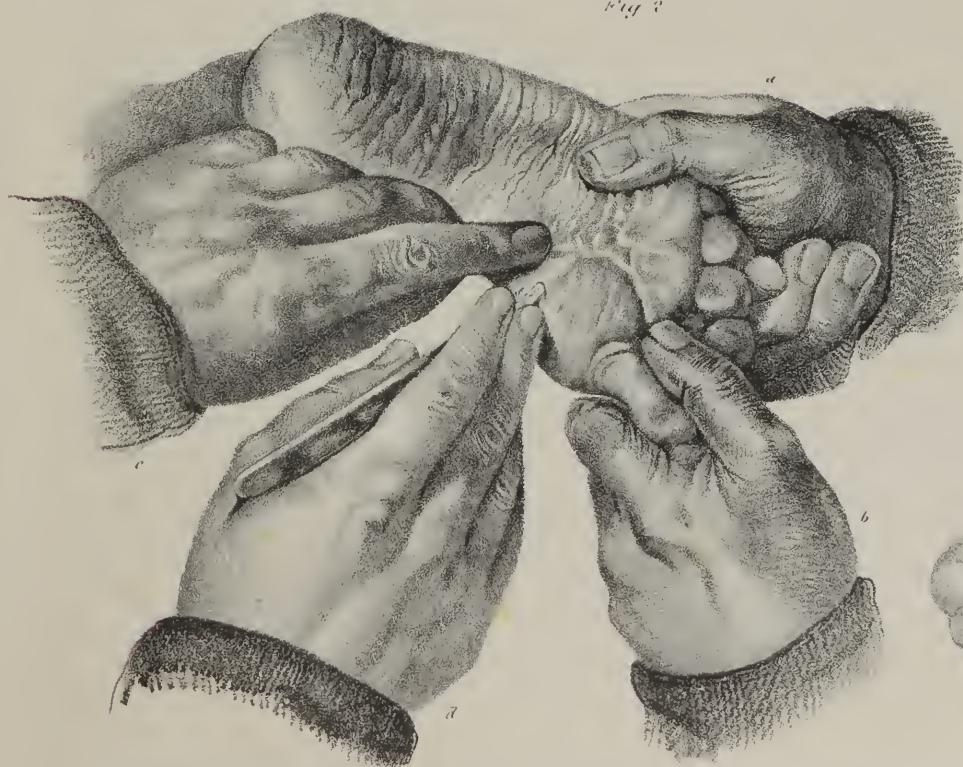
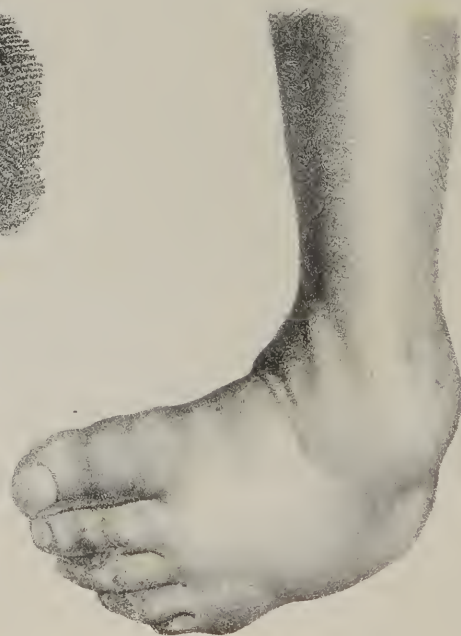


Fig 1



years' duration, some of the deeper-seated parts, as well as the muscles, will be found contracted. I have had on several occasions an opportunity of dissecting carefully under these circumstances the parts around the knee joint, and have observed that, in addition to the hamstring tendons, and the processes of fascia lata by their side, the posterior and crucial ligaments of the joint were so shortened and stiffened by the flexed position in which they had been fixed, that forcible extension could not be effected without their rupture.

When the deformity is occasioned by a previous disease of the membranes of the joint, or is accompanied by caries of the heads of the bones, additional difficulties are commonly met with in the way of cure. These consist, 1st, in a *spontaneous partial luxation of the head of the tibia* backward towards the ham, with more or less deviation upon one side, producing a corresponding lateral deformity of the foot. This is caused partly by the inflammatory softening of the ligaments connecting the tibia and femur, and the vicious position in which the foot and leg have been allowed to rest. It is so common a result, that it has been said by M. Bonnet to attend three-fourths of the cases of angular deformity of this joint. The patella follows the tibia in this displacement. 2d. *Of adhesion of the different parts of the articulation together*, distinct from the bony union of the tibia and fibula which constitutes true ankylosis. This may consist in a firm attachment between the adjoining surfaces of the patella and the condyles of the os femoris—of a union by fibro-cellular matter between the anterior half of the head of the tibia and the condyles of the femur, and finally in thickening of the ligamentous structure at the posterior part of the joint, and the development of cicatrices following ulceration of the parts. 3d. *Alterations of the bones of the joint at the places where they come in contact*. These are always present in a greater or less degree in old deformities which have followed suppuration of the joint, the head of the tibia being more or less flattened and interlocked in an abnormal depression on the back part of the condyles of the femur.

From these brief remarks in reference to the pathological anatomy of the joint, it will be seen that great difficulty must frequently be met with in the attempt to forcibly straighten the limb; that there would be danger, as experience has shown, of increasing the degree of luxation of the tibia backwards, of awakening inflammation in the structures of the joint, and of giving rise to a degree of constitutional irritation that might compromise the life of the patient, whether the attempt be made by the use of machinery alone, or aided by the section of the resisting fibrous bands and tendons. In the severer and older cases of deformity, it would unquestionably be wiser to abandon the case altogether; or, if a curative attempt be made, to proceed with the greatest caution. The milder and more manageable cases of this affection may usually be relieved by the aid of suitable machinery, conjoined with the use of appropriate local applications. The division of the contracted hamstring tendons, but more especially of the aponeurotic bands, and even of the gastrocnemius muscle or tendon may in some instances be made so as to facilitate the use of the mechanical appliances, and diminish the attendant pain and risk.*

* There is one very common deformity of this joint, in which the deviation inwards of the knee is dependent mainly upon relaxation of the internal lateral

Mechanical treatment.—There are two modes of applying the apparatus for the extension of the leg: 1st. That of *insensibly* straightening the limb by the cautious and graduated use of machinery, the one which has chiefly been employed by American practitioners: 2d. That of bringing the limb *immediately* into the straight position, by the application of force sufficient to overcome the resistance. This latter is accomplished by two processes—1st. That of Louvrier, described at page 89, in which the limb is at once straightened by violent *extension*. This method has not proved satisfactory, and has in a great measure been abandoned. 2d. That of Dieffenbach, which consists first in breaking the adhesion between the articular surfaces by *exaggerating the flexion* of the limb, and then making subsequent extension by the aid of the hands alone, or, if a greater effort is required, by the use of an extending apparatus, subsequently wrapping the limb in flannel, and placing it in a carved splint. This process, according to Dieffenbach and Mr. Phillips, is attended with severe pain only at the moment of applying force to bend the joint.

Surgical anatomy.—The tendons of the internal border of the popliteal space, which may be found contracted so as to stand out in relief, are four in number. Starting from the middle of the space and going inward, we encounter, in succession, the semi-tendinosus, the semi-membranosus, the gracilis and the sartorius; the two latter, however, seldom offering much resistance in the straightening of the leg. On the outer border there is but one, that of the biceps. In the middle of the popliteal space, the great nerve of the thigh sometimes forms a resisting cord below the skin, which might be mistaken for a tendon. It may, however, always be identified by its position and its course through the notch between the condyles; for the tendons on either side direct themselves toward the lateral faces of the joint, and may, in addition, be traced upwards with the finger to their connection with the muscles. The great artery and vein are placed too deeply to be endangered in the operation. The tendon of the semi-tendinosus has running along its side next the popliteal space, the internal popliteal nerve, distant below only two or three lines from its border. The external popliteal nerve runs down along the inner edge of the tendon of the biceps, separated from it by a layer of cellular tissue, but gradually getting nearer, as it approaches the joint. The resisting processes of the fascia lata are very obvious just below the skin.

Operation.—The subcutaneous section of these contracted parts is made from above downwards, or from below upwards. The former process is the more easy, the latter the more safe.

Division from above downwards. 1. *Of the bridle formed by the aponeurosis of the fascia lata*, (Pl. LXXX. figs. 1 and 4.)—The patient is to be placed upon his abdomen. The limb is to be laid on the opposite side to the contraction, and extended as far as possible by an assistant. The knife is then introduced below the skin, and the edge turned downwards to divide the fascia.

2. *Division of the Semi-tendinosus and Semi-membranosus*, (Pl. LXXX. fig. 3.)—The limb is to be placed on its external side. A single puncture suffices for the division of both these tendons. It should be made at a little distance from the tendons, and on ligament of the joint. In this case, any use of the knife is utterly wrong. The cure is to be effected by the use of machinery alone.

their inner side. Guérin and Bouvier make a previous puncture with a lancet-pointed knife, and then introduce the tenotome till the point reaches the opposite border of the tendons. The operator ascertains through the skin the position of the point with the fore finger of the left hand, and then divides the tendons partly by pressing and partly by sawing, cutting the semi-tendinosus first.

3. *The section of the biceps* is effected in a nearly similar manner. The knife is entered from the outer border of the limb, and care is to be observed that the point does not pass in the slightest degree beyond the popliteal margin of the tendon, for fear of injuring the adjoining nerve. Both portions of the biceps are to be divided, and the knife carried nearly down to the femur. A piece of adhesive plaster is to be applied over the places of puncture, and the limb placed at once in an apparatus and subjected to moderate extension.

Division from within outwards. (Process of Dieffenbach.) 1. *Of the Semi-membranosus and Semi-tendinosus.*—The puncture should be made about a finger's breadth above the internal condyle of the femur, and as near as possible to the popliteal border of the semi-membranosus in order to avoid the nerve. The knife is to be passed down deep, directed towards the inner side of the leg, so as to get it below both these tendons, which are to be divided across by lowering the handle of the knife and pressing with its edge. If the subcutaneous incision is carried farther, so as to include the tendon of the sartorius, the saphena nerve and vein will be almost inevitably cut.

2. *Division of the Biceps.*—The knife is to be entered in a similar manner, two fingers' breadth above the external condyle of the femur, with its edge to the inner margin of the tendon and the back to the nerve. The point should be carried down nearly to the bone, in a direction slightly slanting outwards, and the section made upwards in the direction of the skin. The leg is

then to be further extended, to see if there are any processes of fascia, or subcutaneous cicatrices, that offer resistance. If such be the case, they are likewise cut below the skin. The blood is then pressed out from the wound, and the orifices closed with adhesive plaster to prevent the introduction of air. The operator then grasps the thigh with one hand, and the foot with the other, and begins a series of forcible flexions of the leg, without attempting to straighten it till he hears a crackling sound, which denotes the rupture of the articular adhesions. The forcible efforts are then continued with a longer sweep till the limb is brought at once into the straight position. If additional difficulty is encountered from the shortening of one of the lateral ligaments, and especially the external, Dieffenbach does not hesitate to divide it with the tenotome. The limb is then to be wrapped in flannel and placed in a hollow tin splint, reaching from the buttock to the heel. The previous flexion of the limb he considers of the utmost importance, in diminishing the risk of rupture of the artery, and disposing the parts better to bear the subsequent extension. Except in the more recent cases, he disapproves of the stretching of the limbs by mechanical apparatus alone, as being both *violent* and *unsafe*.* The reader will be able to judge how far his own method is free from similar reproaches.

Section of the muscles and fascia for contraction at the hip-joint.

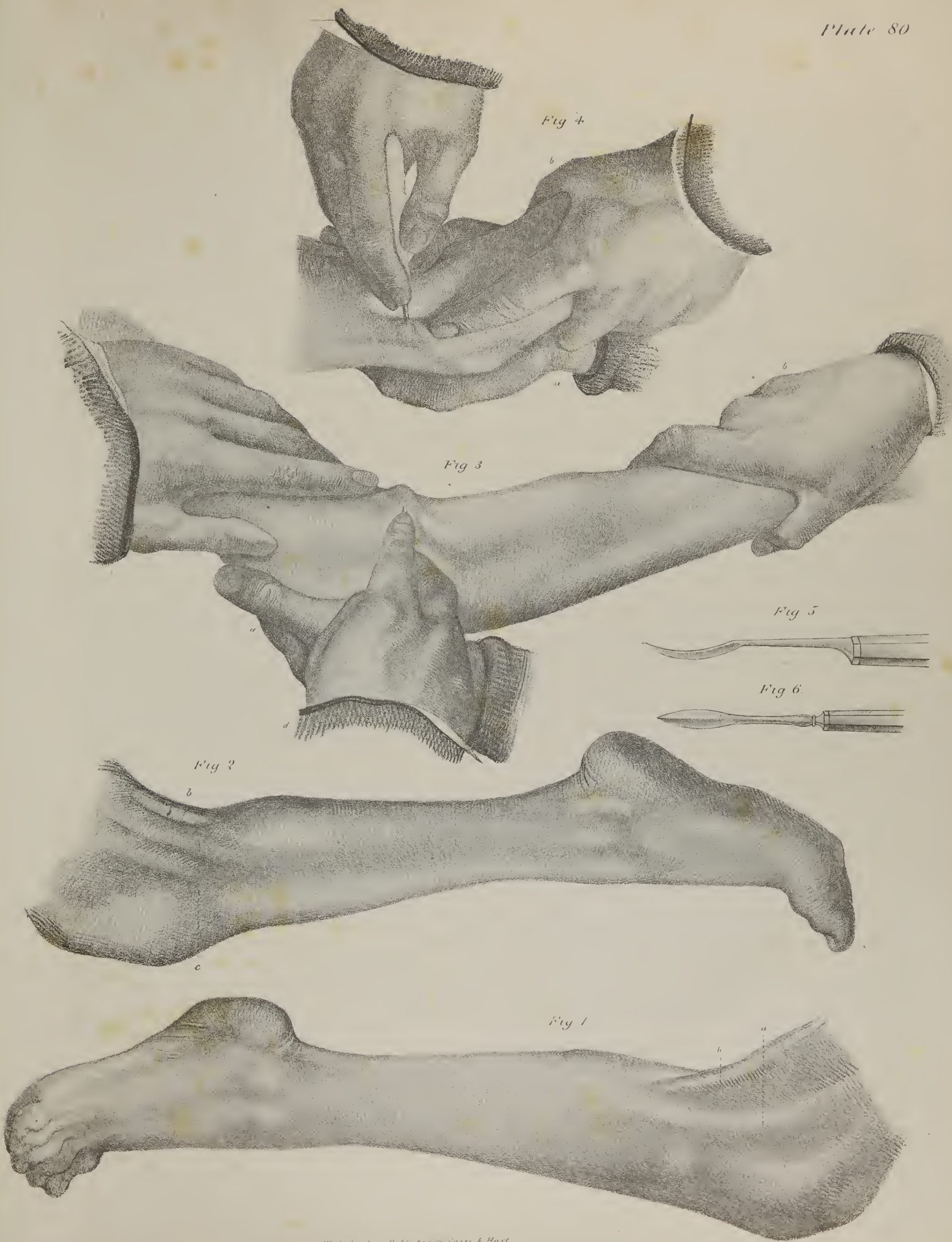
—The parts that have been divided are the pectineus, the rectus, and tensor vaginæ femoris muscles, and the outer portion of the fascia lata. The deformities of this joint, for which these operations have been practised, have occurred chiefly from mal-position, the consequence of long-standing contraction of the foot or knee. In one instance, Dieffenbach resorted to this expedient, for the purpose of reducing, in a child six years old, a subluxation of the head of the bone, occasioned some time previously by coxalgia. The knee was fixed in an elevated position. By fol-

* Klinische.

PLATE LXXX.—SUBCUTANEOUS OPERATIONS.

RETRACTION OF THE HAMSTRING MUSCLES.

- Fig. 1.*—Outer face of the limb showing the rigid elevation (*a*) made by the action of the gluteus maximus muscle on the fascia lata. The prominent cord formed by the tendon of the biceps flexor cruris is seen at *b*.
- Fig. 2.*—The same limb seen on its internal face. *b*. Tendon of the biceps. *c*. The projections formed under the skin by the semi-tendinosus and semi-membranosus, and the sartorius and gracilis muscles. In this case, there was a tendency to subluxation of the patella outward, in consequence of the lateral traction made by the aponeurosis and the shortening of the gastrocnemii muscles, which had caused a talipes equinus.
- Fig. 3.*—*Section of the semi-tendinosus and semi-membranosus muscles.*—The puncture is made from before backwards. An assistant presses with one hand (*a*) upon the patella, and with the other (*b*) endeavours to extend the leg. The surgeon applies his left hand (*c*) upon the posterior part of the thigh, while he introduces the knife for the purpose of making the section with the right.
- Fig. 4.*—*Section of the tendinous cord formed by the elevation of the fascia lata, seen in fig. 1.*—The knife is introduced from behind forwards, under the cord. The limb is steadied by an assistant, who grasps it upon its inner face with his left hand (*a*). The surgeon with his left hand (*b*) presses the limb against the palm of the assistant, so as to efface the curvature made on its external face while he divides the cord with a knife in his right.
- Fig. 5.*—*The medium-sized tenotome of M. Guérin, with a short, crescent-shaped blade, convex on its cutting edge, and made with a long rounded shank, to avoid the extension of the incision in the skin.*
- Fig. 6.*—*Lancet, in the form of a double-edged spatula, with which the puncture is made, for the introduction of the crescent-shaped tenotome.*



lowing up the section of the rectus femoris and the fascia lata with extension of the limb, he is said to have been successful in restoring the head of the bone to its former position.*

The division of the rectus femoris, tensor vagina and fascia, may be made from the same place of puncture; but that of the first is rendered somewhat difficult and dangerous by the proximity of the large vessels of the thigh. The parts are to be put upon the stretch. The knife is entered two inches below the anterior superior spinous process of the ilium, and carried along under the skin parallel with Poupart's ligament, till it reaches the internal edge of the rectus; this muscle is then to be divided by depressing the blade. From the same place of puncture the knife is to be carried outwards in order to divide, in a similar manner, the tensor vagina femoris and the resisting portion of the fascia lata. For the division of the pectineus, a new puncture is required on the inner side of the thigh, near the border of the prominence formed by the contracted muscle.

The same process of section of the tendons and forcible and sudden extension has been applied by Dieffenbach to contractions of the fingers and toes.

OF THE UPPER EXTREMITY.

It has already been observed that the subcutaneous section of the tendons of the upper extremity has not been attended with the same degree of benefit as in the lower. In the foot, shape and position are objects of greater importance than the preservation of muscular action; but the reverse is the case as regards the wrist and fingers. At the wrist, the tendons, instead of being embraced in a dense cellular sheath, like the tendo-Achillis, are invested with a delicate synovial membrane, which secretes a glairy fluid, and thus presents a serious obstacle to the reunion of the ends. This non-union of the tendons, which should be looked for as the most common result, must of course be followed, to a greater or less extent, with loss of use of the muscles to which they belong.

In view of these results from tenotomy, an attempt has been made to relieve the deformity by dividing with the knife the bellies of the affected muscles high in the fore arm; but, apart from the difficulty of the operation, and the danger of dividing the nerves, their attachment down the bones of the fore arm is so extensive as to render the operation unavailing.

For these reasons, the author has rarely deemed it advisable to resort to tenotomy in deformities of the wrist or fingers, except in cases where one finger is flexed so as to interfere with the action of the wrist, or the whole are permanently contracted in the palm, so as to completely destroy the usefulness of the member. It is usually in the sense of flexion that these deformities occur. They are rarely ever congenital; sometimes they arise in consequence of wounds or fractures of the fore arm, but commonly may be traced to some central lesion of the nervous system.

SUBCUTANEOUS SECTIONS FOR THE CURVATURE OF THE HAND AND FINGERS. (CLUB-HAND.)

These are to be accomplished precisely as directed for the

other subcutaneous operations, and need not be particularly described. It may be well, however, to observe, that the division of the flexor tendons should never be made on a level with the head of the first phalanx, as this would destroy the split in the superficial tendon through which the deep-seated plays. It is equally disadvantageous to divide the latter tendon on a level with the second phalanx, as the retraction of the muscle would, in all probability, even without any forced straightening of the finger, draw the upper section through the groove so as to leave the finger motionless. If the operation be undertaken, it should therefore be done upon the prominent tendon or tendons affected, either in the palm or above the carpal joint.

Of the tendons in the palm.—If the section is made in the palm, great care must be taken especially in acting on the tendons of the flexor profundus to avoid injuring the median nerve. Each tendon should be divided separately; if the finger is not then readily extended, it may be straightened by a sudden effort and supported by a splint, on the principle of treatment employed by Dieffenbach for angular ankylosis of the knee joint. In case the flexion of the fingers be manifestly due to paralysis of the extensor muscle, a trial might be made of the ingenious suggestion of Sir C. Bell, of applying a watch-spring on the dorsal surface so as to antagonize the action of the flexors.

Of the palmar aponeurosis.—For a long time it was believed that the shortening or increased tension of this membrane was, as taught by Dupuytren, the common cause of permanent flexion of the fingers. Though it has been shown that the cause is mostly to be found in the flexor muscles and tendons, cases do occasionally occur in which the aponeurosis alone or conjointly with the muscles produces this deformity, and requires to be divided. In such instances the aponeurosis and its digitating branches are found hard and prominent in the palm. These digitations are attached to the ends of the metacarpal bones, and likewise (though it has been denied by some surgeons) on either side of the first phalanx of each finger. In the diseased condition, additional bridles or bands of attachment to the bone become apparent, while the aponeurosis is found closely adherent to the skin and occasionally to the upper surface of the superficial flexor tendons. The result of the morbid contraction is not only a hook-like flexion of the fingers upon the palm, but also an inversion of the ends of the metacarpal bones. The ring and little finger are the two most commonly affected.

Operation. (Process of Sir A. Cooper.)—Extending the fingers in succession so as to render the resisting bridles conspicuous, a narrow-bladed knife is to be introduced by puncture below the skin, so as to divide them from above downwards. The introduction of the knife at several points will usually be required, and the section of the bridle may be made either in a transverse, oblique, or longitudinal direction. The section is to be continued until the fingers can be straightened by the application of moderate force. If the tendons of the superficial flexors are adherent to the aponeurosis, it may become necessary to divide them also, though this, it must be remembered, will be attended with great risk of the loss of function. This method causes but little pain to the patient, and is not followed by suppuration or any other serious symptom. In some instances, however, it may, from the close adhesion of the skin, be found inapplicable. It then be-

* Chirurgie de Dieffenbach, p. 48.

comes necessary to divide the skin with the fascia, as in the processes of Dupuytren and Goyrand. Dupuytren not only cut the skin along with the most prominent part of the bridge, (which is usually at the junction of the first phalanx with the palm,) but, when requisite, dissected back the lips of the wound in order to reach—on each side of the metacarpal bones and the phalanges—the shortened bridges which he divided with the point of the knife. He sometimes found it necessary to make a second section of the skin and fascia over the first or second phalanx. A special operation is required for each finger. M. Goyrand divides the skin longitudinally for an inch parallel with and by the side of each prominent cord, raises the skin by dissection, and cuts across with the knife the cords thus laid bare. The fingers are then extended on a splint, and the wounds united by first intention. The longitudinal opening of the skin prevents the gaping of the wound, which is observed during extension after the operation of Dupuytren. This process, though tedious and painful, is preferable to that of Dupuytren.

SECTION OF THE FLEXOR TENDONS ABOVE THE WRIST.

Section of the tendons of the flexor sublimis digitorum.—This is an operation of some delicacy. On either side of the four tendons we have passing down the radial and ulnar vessels and nerves, and below them—next the deep-seated flexor—is the median nerve and an artery which attends it. From all these parts the edge of the knife must be cautiously kept. The division may, however, be made after the manner of MM. Bouvier and Guérin, by first puncturing the skin on one side of the tendons, then extending each finger in succession so as to raise its particular cord, gliding below a blunt-pointed knife and dividing each cord in succession towards the skin.

If there is a permanent flexion of the wrist unaccompanied with that of the fingers—a kind of deformity I have several times met with accompanying congestive affection of the brain—the use of a straight splint and bandage or other appropriate machinery will be found sufficient for the cure. The tendons of the radial and carpal flexors, which are the muscles then at fault, could, however, if necessary, be divided by puncturing the skin and introducing a blunt-pointed knife between each of the tendons and the radial or ulnar arteries which run by their sides.

DEFORMITIES OF THE ELBOW JOINT. (PL. LXXVII. FIGS. 4, 5.)

Next to the knee, the elbow joint is the one most frequently found more or less flexed and rigid. The causes which contribute to produce this effect are much the same in both, though in the elbow it is less frequently dependent upon muscular retraction merely. The shortening of the biceps—which is the only muscle that offers much resistance to extension of the forearm—is usually observed as the consequence of some previous disease that has retained the limb flexed, or united the articular surfaces by adventitious bridges. In such cases, if we are able to restore the motion of the joint by proper medical and mechanical manipulation, little difficulty will be encountered in subsequently stretching the biceps muscle. In those instances—but rarely, however, met with—where the flexion has been produced by an organic altera-

tion of the muscle of the kind so commonly observed in cases of club-foot, the section of the tendon may be attended with advantage, as it will facilitate the action of the apparatus for extending the joint. The process for dividing the tendon will be well understood by referring to plate LXXVII.

Section of the tendon of the triceps.—In ankylosis following fracture of the arm, with permanent extension of the elbow joint, Dieffenbach has cut the tendon of this muscle at its attachment to the olecranon, and by great efforts forced the fore arm into a flexed position. In the course of a few days the patient is said to have regained the use of the arm.

It can seldom or ever, I believe, be necessary to resort to this operation. In most of the cases of this description which have come under my care, the chief source of the resistance has been in the thickening of the ligament or the attachment between the surfaces of the joint—all of which might readily have been obviated by the proper use of passive motion of the articulation during the union of the broken fragments. By the use of appropriate local applications, and the resort to force to bend the arm, either suddenly by the hands or more gradually through the use of a proper apparatus—I have rarely ever failed to restore motion in these cases without resorting to a division of the triceps tendon.

The application of the subcutaneous method for the cure of strabismus, for the removal of foreign bodies and dropsical collections from the joints, and for the obliteration of varicose veins, has been already referred to in other parts of this work. It has been proposed to extend it to a variety of other affections, which it will suffice here briefly to notice.

Hernia.—MM. Guérin and Diday have in particular resorted to this method, in cases of strangulated recent herniæ, *when there was no reason to believe that the stricture was seated at the neck of the sac, or that the part strangulated was gangrenous.* The process employed by Guérin in a case of inguinal hernia, consisted first in raising a fold of skin at the root of the scrotum, puncturing the fold at its base with a lancet-shaped knife which he carried up to the level of the external ring, and then substituting for the knife a grooved director, which was insinuated in the direction of the canal between the ring and hernial tumour. The director was sustained in this position by an assistant. The surgeon then raised another fold above the first, punctured it in like manner, and carried up through the puncture a blunt-pointed tenotome with a short cutting edge and a long rounded shank. The knife was then run up along the groove of the director, with its edge turned in the direction usually advised in the operation for hernia, so as to divide the stricturing band. In order to diminish the hazard of wounding some important part necessarily attendant upon this operation, the entering end of the director should be elevated as far as possible with the surgeon's left hand, and the hernial tumour, if its contents are found to bulge up so as to increase the risk of their being wounded, should be grasped by an assistant and drawn downwards. After the stricture is relieved, the tumour is to be reduced, the blood and air carefully pressed out from the track of the wound, the punctures closed with adhesive plaster, and the part supported by a compress and spica bandage.

I performed this subcutaneous operation for hernia, about twelve months since, with the most gratifying success, in the

case of a Mr. Wildy, a patient of Dr. Knorr, of this city. The patient was a middle-aged muscular man, and had had, for many years, a reducible inguinal hernia upon the right side. In March, 1844, it came down and could not be returned; there were some soreness and general uneasiness, and his physician tried all the ordinary measures of relief by the taxis without success. On the second day after the descent of the hernia I was called in consultation. There was then complete strangulation, with all its attendant train of bad symptoms. The stricture could be distinctly felt at the external ring; and there was reason to believe, *from the state of the patient, and from the recent occurrence* of the strangulation, that the condition of the strangulated parts was such as to have rendered the recovery of the patient sure, provided it had been possible to reduce them by the ordinary taxis. I determined, therefore, to divide the stricture by a subcutaneous incision, as without this the taxis was altogether impracticable, and there was no other alternative but the common operation for hernia by the free division of its coverings, which must leave an open suppurating wound that would confine the patient for two or three weeks to his bed. I accordingly raised a transverse fold of skin about an inch and a half high immediately below the external ring, and punctured it at its base with a sharp-pointed bistoury, but *taking especial care to carry the point of the instrument in front of the upper column of the ring*, which could be distinctly felt with the finger. I then, without relaxing the fold, withdrew the bistoury, and inserted in its place a grooved director, the end of which I insinuated for near an inch under the upper column of the ring, and of course between it and the cremaster fascia covering the sac. I then relaxed the fold and smoothed it out on the director; then placing my left fore finger under the director, and the thumb on the outer end, I strained, as it were, the column of the ring upwards till I could see the outline of the director through the skin. I then dropped vertically through the skin, immediately below the ring, the end of a sharp-pointed curved bistoury into the groove of the director, and inclining the heel of the instrument backwards, slid the point forward in the groove and divided the stricturing edge of the column for about a half an inch. The division of the tendon was accompanied with the usual creaking sound. The bistoury and director were now removed, and but a few drops of blood escaped by either puncture. The patient was then placed in the usual position for the taxis, and the contents of the hernial sac were returned, without the slightest difficulty, into the abdominal cavity, with immediate relief to the patient. On the second day, the punc-

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tures, which were scarcely distinguishable among the wrinkles of the skin, were healed, and the patient got up perfectly well, re-applied his truss, and resumed his ordinary business.

It is to cases of this description, and this alone, that I believe the subcutaneous operation for hernia should be restricted; and under such circumstances, where there is proper skill displayed in the diagnosis, and extreme caution in the use of instruments, it may, I have no doubt, be occasionally resorted to with great advantage.

Division of the sphincter ani.—MM. Blandin, Brachet, and others, have divided the sphincter muscle by a subcutaneous section, with the object of relieving its spasm in cases of fissure of the anus, without exposing the track of the wound to irritation from the feculent contents of the bowel. A finger is to be passed into the rectum; a narrow, sharp-pointed bistoury, convex on the back, is then introduced by puncture at the margin of the anus on the side opposite to the point diseased, and carried up on the outer side of the mucous membrane for the distance of an inch and a quarter, the pulpy end of the finger serving as a director for the passage of the instrument. The edge of the knife is then to be pressed outwards and made to divide the sphincter as it is withdrawn, without enlarging the external wound.

Myopia.—*Kopiopie.*—In cases of myopia, and in that state of the eye in which there is excessive tendency to fatigue on any prolonged use of the organ (denominated by M. Petrequin *kopiopie* or *ophthalmokopie*), produced merely by inordinate muscular compression, M. Bonnet has advised the division of the inferior oblique muscle with a narrow knife introduced by puncture of the skin near the internal canthus.

Subcutaneous incisions have likewise been recommended for the cure of hydrocele, for the treatment of phlegmonous and lymphatic tumours, with a view of producing disgorgement and facilitating absorption without the production of an obvious cicatrix, for the evacuation of meliceris tumours, for the dissipation of small periosteal swellings, for the radical cure of hernia, and for the section of nerves in cases of neuralgia. But in the first three of these affections, as well as in the three above noticed, the application of the method is to be considered merely in the light of ingenious suggestions, to be ranked with the many doubtful forward movements to which many have been led by the love of scientific innovation, of which the value, if value they have, yet remains to be attested by experience.

THE END.

